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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ2150 for a patent by PETER ROBERT RAFFAELE and MICHAEL JOHN RAFFAELE filed on 11 August 1999.



WITNESS my hand this
Eleventh day of April 2000

LEANNE MYNOTT
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AUSTRALIA
Patents Act 1990
PROVISIONAL SPECIFICATION
FOR A PROVISIONAL PATENT

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Invention Title: Improvements In Fluid Devices

The following statement is a description of this invention

This invention relates to reciprocating fluid devices colloquially known as "scotch yoke" devices. In our earlier filed application Nos. PP9266, PP9306, PP9573, PQ0287, PQ0795, PQ0895, PQ0972, PQ0989, PQ1653 and PQ1654, the contents of which are incorporated herein, we have also proposed scotch yoke type fluid devices in which each piston may be decoupled from any other piston mounted on the same big end of a crank, so allowing each piston to move along a cylinder axis which may be at an angle to any other cylinder axis. In producing such devices it has been discovered that the pistons may be rotated in the cylinders about an axis generally perpendicular to the cylinder axis, causing damage to the device. To prevent this occurring it has been proposed to use guide means mounted on, connected to or integral with the piston to maintain the pistons in a correct orientation and to prevent unwanted rotation or deflection of the piston. In our earlier applications we also proposed guide means located outward of the piston and cylinder bores. This requires extra space within the crank case and so increases the size of the fluid device.

In an attempt to ameliorate at least some of the above disadvantages, in one broad form, the invention provides a fluid device including:

- a crank mechanism including a big end bearing which orbits about a main axis, the big end bearing having a big end axis;
- 20 connecting means rotatably mounted on the big end bearing for rotation about the big end axis;
- 25 at least one piston located for reciprocal motion in a cylinder along a cylinder axis, the or each piston having first guide means which engages engagement means on the connecting means, said connecting means reciprocating along a path relative to the piston and the first guide means between two end points;
- at least one second guide means associated with the or at least one of the at least one piston for constraining the respective piston to move along the respective cylinder axis;
- 30 wherein the first guide means extends partially or totally across the cross sectional area of the respective piston perpendicular to the cylinder axis; and

wherein the second guide means is located transversely relative to the said path.

Preferably the second guide means is located between the two end points

- Preferably the first second guide means are contained within a volume defined by
- 5 a projection of the cylinder's cross sectional area along the cylinder axis. However, the first or second guide means, or both, may extend out of this volume. Further, the second guide means may lie within the volume but may be positioned not between the two end points.

- The first and second guide means may be formed integral with the piston body or
- 10 may be one or more separate items attached to the piston body. Where the guide means are separate units, a single unit may be provided which is rigidly or pivotably mounted to the piston body. The second guide means may include one or more guide members, including tubes or rods, which extend substantially parallel to the piston axis. Where the guide means comprises two or more guide
 - 15 members, these guide members may be located symmetrically or asymmetrically relative to the piston's cross sectional centre.

Preferably the first guide means extends through the centre of the piston's cross sectional area.

- Where two or more pistons are mounted on one big end, the pistons may lie in a
- 20 single plane or may lie in two or more planes.

- In our earlier application No PQ0795 we have described how a fluid device may be fully or substantially statically or dynamically balanced or both about the crank axis. It will be appreciated that the additional mass of the second guide means may be balanced as described in the earlier application. It will also be
- 25 appreciated that whilst balancing of pistons mounted on a single crank is the norm, balancing of a device with pistons mounted on separate big ends is possible if the big ends are coaxial.

The invention shall be better understood from the following description of non-limiting embodiments and the drawings, in which:

- 30 Figure 1 is a perspective view of a piston made according to the invention.
- Figure 2 is a perspective view of the Figure 1 piston taken from a different angle.

Figure 3 is a perspective view of a fluid device incorporating the piston of Figures 1 and 2.

Figure 4 is a detailed view of a portion of the device of Figure 3.

Figures 5 to 46 show underside plan views of various pistons made according to
5 the invention.

Figures 47 to 49 show isometric views of a further piston made according to the
invention.

Figures 50 to 52 show isometric views of a further piston made according to the
invention.

10 Figures 53 to 55 show isometric views of a further piston made according to the
invention.

Figures 56 to 58 show isometric views of a further piston made according to the
invention.

15 Figures 59 to 61 show isometric views of a further piston made according to the
invention.

Figures 62 to 64 show isometric views of a further piston made according to the
invention.

Figures 65 to 67 show isometric views of a further piston made according to the
invention.

20 Figures 68 to 70 show isometric views of a further piston made according to the
invention.

Figures 71 to 73 show isometric views of a further piston made according to the
invention.

Figures 74 to 76 show isometric views of a further piston made according to the
25 invention.

Figures 77 to 79 show isometric views of a further piston made according to the
invention.

Figures 80 to 82 show isometric views of a further piston made according to the
invention.

Figures 83 to 85 show isometric views of a further piston made according to the invention.

Figures 86 to 88 show isometric views of a further piston made according to the invention.

- 5 Figures 89 to 91 show isometric views of a further piston made according to the invention.

Figures 92 to 94 show isometric views of a further piston made according to the invention.

- 10 Figures 95 to 97 show isometric views of a further piston made according to the invention.

Figures 98 to 100 show isometric views of a further piston made according to the invention.

Figures 101 to 103 show isometric views of a further piston made according to the invention.

- 15 Figures 104 to 106 show isometric views of a further piston made according to the invention.

Figures 107 to 109 show isometric views of a further piston made according to the invention.

- 20 Figures 110 to 112 show isometric views of a further piston made according to the invention.

Figures 113 to 115 show isometric views of a further piston made according to the invention.

- Referring to Figures 1 to 4 there is shown a V-twin fluid device 10 having two pistons 12 reciprocating in cylinders 14 at 90° to each other, although other angles are possible. A connecting means 16 is rotatably mounted on a big end of a crank (not shown) and slidably engages the two pistons 12.

Each of the pistons 12 has a T-shaped slot 18 which extends diametrically across each piston. The connecting means has corresponding T-shaped tongues 20 which engage in the slots 18. Each of the tongues 20 has a two part construction

- the cross arms are formed of a planar web 24 which is attached to the vertical web 26 by bolts 28.

- Located on either side of the slot 18 are two axially extending planar webs 30. These webs 30 are diametrically opposite each other and extend perpendicularly to the slot 18 but do not extend out of the bore of the piston. The webs 30 are integral with the piston body.
- 5

The fluid device has a series of U-shaped guides 32 which engage the webs 30, as seen in Figures 3 and 4. The guides 32 are rigidly mounted on the crank case (not shown) and so aid in limiting any wobbling of the pistons as they move within 10 the respective cylinders.

The guides are preferably located on the crank case by way of a locating pin 34 and then bolted via bolt holes 36.

The guides 32 serve to limit movement of the pistons both parallel and transverse to the slot 18 and so enable the skirt length of the piston to be reduced, if 15 desired.

Because the webs 30 are located to the side of the slot, rather than at one of its ends, the size of the crank case need not be any greater than a conventional crank case. Further, because the webs 30 do not extend out of the bore of the piston, an existing crank case can be relatively easily modified to take the crank 20 and piston assembly.

The webs and the slot 18 may be formed integral with the piston and so be formed of the piston material. Alternatively separate components may be provided and the piston assembly built up from those components. Preferably the bearing surfaces of the slot 18 and the webs 30 are suitably treated to provide a 25 hard wearing surface or are provided with separate inserts to provide a suitable surface. It is to be understood that oil lubrication will be provided to the bearing surfaces via oil galleries or by oil splashing.

Figures 5 to 46 show bottom plan views of different configurations of piston webs or vertical guide means which may be used with the connecting means shown in 30 Figures 3 and 4. The guides corresponding to the vertical webs of each piston are not shown but it will be apparent that the guides need to have a shape corresponding to the surface of the webs.

Figure 5 shows a piston 40 having a single axial web 42. The web 42 extends perpendicular to the slot 18 along a radial line. The web 42 also extends beyond the piston's circumference. The web 42 may be integral with the piston or a separate component.

- 5 Figure 6 shows a piston 44 having two parallel webs 46 extending perpendicular to the slot 18 along a diametrical line. The webs 46 extend beyond the piston bore to engage guides, 32. Each web is a separate component and engages in an axially extending slot 48 on the piston.

10 Figure 7 shows a piston 50 having two separate as opposed to integral webs 52 which engage in slots 54 in the piston. Otherwise, this structure is similar to that of the Figure 1 and 2 pistons.

Figure 8 shows a piston 56 with a similar construction to that of the Figure 1 and 2 piston except that webs 58 extend beyond the bore of the piston.

15 Figure 9 shows a piston 60 having two axially extending slots 62 which engage axially extending webs 64 mounted on the crank case.

Figure 10 shows a piston 66 having an axially extending web 68 which is located at one end of the slot 18 and is engaged by a U-shaped guide 70.

Figure 11 shows a piston 72 having a single integral web 74.

20 Figure 12 shows a piston 76 having three webs 77, 78 and 79. One web 77 extends perpendicular to the slot 18 from the centre of the piston 76 whilst the other two webs 78 and 79 extend perpendicular to the slot from its other side. The webs 78 and 79 are spaced apart and located towards the ends of the slot 18. All three webs extend beyond the piston's circumference.

25 Figure 13 shows a piston 80 similar to that of Figure 12 except that the two webs 78 and 79 are much closer together and located toward the centre of the slot 18. In addition the single web 77 remains within the piston's circumference.

Figure 14 shows a piston 82 having two T-shaped members 84 extending diametrically opposite to each other perpendicular to the slot 18.

30 Figure 15 shows a piston 86 similar to that of Figure 14 but having a single T-shaped member 88 extending from the centre of the piston.

Figure 16 shows a piston 90 having two T-shaped members 92 which are offset from the centre of the piston. The offset is symmetrical about the piston's centre, but need not be.

- Figure 17 shows a piston 94 similar to that of Figure 14 except that the T-shaped members 96 remain within the bore of the piston.

Figure 18 shows a piston 98 having Y-shaped axially extending webs 100 which extend from the centre of the slot 18.

Figure 19 shows a piston 102 having two planar webs 104 extending from the centre of the slot 18 but about 45° rather than 90°.

- 10 Figure 21 shows a piston 104 having four webs 106 extending perpendicular to the slot 18. Each web is engaged by a respective guide member.

Figure 22 shows a piston 106 in which two pairs of L-shaped members 108 define two axially extending T-shaped slots 110 into which a T-shaped guide member (not shown) engages.

- 15 Figure 23 shows a piston 112 having two webs 114, each of which has a concave surface 116 for engaging a complementary guide means. The surfaces 116 may be elliptical, circular or any other shape.

Figure 24 shows a piston 118 having two webs 120 with convex surfaces 122. These surfaces 122 may be elliptical, circular or any other shape.

- 20 Figure 25 shows a piston 124 with two webs 126 similar to those of the Figure 24 device but in which the webs 126 are offset in opposite directions from the centre of the slot 18. The offset may be symmetrical or asymmetrically.

- 25 Figure 26 shows a piston 128 with two webs 130 having convex surface 132. A slot 134 extends inwardly from the convex surface 132 towards the centre of the slot 18.

Figure 27 shows a piston 136 having two webs 138 extending perpendicular to the slot 18 but both are offset from the centre of the piston and are opposite each other.

- 30 Figure 28 shows a piston 140 with two axially extending webs 142. Each web has an undulating surface 144 which engages a corresponding guide surface. These

undulating surfaces 144 may be arcuate, ellipsoidal or any other suitable shape. The shape may be regular or irregular.

- 5 Figure 29 shows a piston 146 similar to that of Figures 12 and 13 in having rectangular cross section webs, 148. However the webs 148 do not engage and are not integral with the housing for the slot 18. Instead the webs extend from the underside of the piston.

- 10 Figure 30 shows a piston 150 having two webs 152 extending downwards from the main body of the piston separately from the housing for the slot 18. Each web is formed of two arms 153, 154 which extend at 90° to each other. The arms may extend at other angles.

- Figure 32 shows a piston 156 with two axially extending members 158. The members 158 have, in cross section, a mushroom shape.

- Figure 33 shows a piston 160 with two axially extending members 162 which do not engage the housing for the slot 18.

- 15 Figure 34 shows a piston 166 similar to that of Figure 33 but with four axially extending members 168. Two of the members 168 are located on either side of the slot 18. The arrangement of the four members is preferably symmetrical about the centre of the piston.

- 20 Figure 35 shows a piston 170 with two pairs of guide members. A first pair 172 extends from the underside of the main body of the piston and has a circular or elliptical outer surface 174. The other pair 176 extend from the circular peripheral surface of the piston.

- Figure 36 shows a piston 178 having four axial guide members 180 extending from the circular peripheral surface of the piston.

- 25 Figure 37 shows a piston 182 having a substantially rod shaped guide member 184 extending axially. The guide member 184 is integral with or mounted to the peripheral surface of the piston.

- Figure 38 shows a piston 186 similar to that of Figure 10 except that two guide members 188 are provided at one end of the slot 18.

Figure 39 shows a piston 190 with two guide members 192 extending axially and generally radially from the housing to the slot 18. Each member 192 has undulating side surfaces 194. These may have any shape desired.

- 5 Figure 40 shows a piston 196 with three guide members 197, 198 and 199. The guide member 197 extends perpendicularly to the slot 18 whilst members 198 and 199 extend divergently to each other from the slot 18. Preferably all three members extend radially from the slot 18.

- 10 Figure 41 shows a piston 200 having a single guide member 202 extending axially. The guide member 202 has concave sides 204 and planar outer surface 206. Preferably surface 206 is parallel to the slot 18.

- 15 Figure 42 shows a piston 206 having three axially extending guide means 208, 210 and 212. Guide member 208 is a simple rectangle in cross section, guide member 210 is F-shaped in cross section whilst guide member 212 has a central spine with arms 216 and 218 extending from its side. The arms 216 and 218 may have the same or different lengths.

- 20 Figure 43 shows a piston 220 having at least one roller 222 mounted on each side of the slot 18 by axle pins 224. The rollers 224 engage an axially extending guide 226 mounted on the crank case. The piston may be provided with two or more rollers on either side of the slot 118

- 25 Figure 44 shows a piston 228 having two rectangular section tubes 230 extending axially on either side of the slot 18. These tubes 230 are open at at least one end and receive axially extending guide rods mounted on the crank case.

- Figure 45 shows a piston 232 having triangular shaped guide members 234 extending axially on either side of the slot 18.

- Figure 46 shows a piston 236 having a guide member 238 with triangular indents 240 in its two sidewalls.

- 30 Figures 47 to 49 show a piston 242 with a vertically extending guide bar 244 and a horizontal slide bar 246. The bar 244 extends from the lower surface of the main body 248 of the piston. The horizontal bar 246 is mounted on an inner side of the vertical bar 244. The bar 246 is engaged by a suitable engagement means on the connecting means whilst the vertical bar 244 is engaged by a suitable guide surface mounted on the crank case.

Figures 50 to 52 show a piston 250 with a vertical guide bar 252 and a horizontal bar 254. The horizontal bar 254 has a re-entrant slot 256 for slideably engaging a corresponding tongue on a connecting means.

- Figures 53 to 55 show a piston 258 having a main body 260. Rotatably mounted to the main body by a gudgeon pin 262 is a engagement/guide means 264. This engagement means includes a horizontally extending portion 266 and a vertical extending portion 268. The horizontal portion includes a slot 270 which slideably receives a complimentary tongue on the connecting means whilst the vertical portion is engaged by a guide mounted on the crank case. It will be noted that the vertically extending portion extends above and below the horizontally extending portion.

- Figures 56 to 58 show a piston assembly 272 with a Z-shaped horizontally extending member which slideably engages a complimentary surface on the connecting means.
- Figures 59 to 61 show a piston assembly 276 in which a vertical guide bar 278 extends from the base of the main body of the piston 280. A horizontal bar 282 is mounted on the main body 280 independently of the vertical guide bar 278.

- Figures 62 to 64 show a piston assembly 282 having a main body 284 and an engagement/guide assembly 286 mounted to the main body by pins or bolts 288. The engagement/guide assembly has two vertical legs 290 and a cross bar 292. Mounted on the cross bar is a horizontally extending T-shaped engagement member 294 which extends perpendicular to the plane of the two vertical guide bars 290. This member 294 is engaged by the connecting means.

- Figures 65 to 67 show an assembly 296 similar to that of Figures 62 to 64 and a similar engagement/guide assembly 300 is mounted to the main body 298 of the piston. The assembly 300 is mounted to the main body 298 by a gudgeon pin 302 which extends in the plane of the two legs 290. The assembly 300 may pivot about the pins 302.

- Figures 68 to 70 show a piston assembly 304 having a main body 306 on which is mounted an H-shaped guide assembly 308. The assembly is mounted to the main body 306 via pins 310. Mounted on the cross bar 309 of the assembly 308 is a horizontally extending engagement bar 312. The bar 312 is pivotably mounted to bar 309 via pin 314. The bar 312 has a T-shaped slot 316 for engaging a T-shaped tongue on the engagement means.

Figures 71 to 73 show a piston assembly 318 having a guide/engagement means 320 mounted to the main body 322 via pin 324. A cross-bar 326 extends between vertical members 328 and includes a T-shaped slot 330.

- Figures 74 to 76 show a guide engagement assembly 332 having a cross bar
- 5 334, four vertical guide bars 336 and a central connecting bar 338. There are two vertical guide bars 336 on either side of the cross bar 334. The cross bar has a T-shaped slot.

- Figures 77 to 79 show an assembly similar to that of Figures 74 to 76 except that the cross bar 340 is T-shaped, rather than having a T-shaped slot.
- 10 Figures 80 to 82 show an assembly 342 similar to that of Figures 77 to 79 attached to a piston body 344 by two pins 346 so that pivoting is not possible.

- Figures 83 to 85 show a piston assembly 350 having a guide/engagement means 352 mounted on a pin or cross bar 354 of the piston body 356. The pin or cross bar 354 may be separate from or integral with the body 356. The assembly is
- 15 retained on the cross bar 354 by bolt 358.

- Figures 86 to 88 show a guide/engagement assembly 360 similar to that of Figures 74 to 76 but retained on the piston body 362 by two pins 364.

- Figures 89 to 91 show a piston assembly 366 functionally identical to that of Figures 86 to 88 but in which there is a single unitary structure and only one
- 20 vertical guide bar 368 on each side of the horizontal engagement bar as opposed to two.

- Figures 92 to 94 show a piston assembly 370 similar to that of Figures 47 to 49 but in which a horizontal slot 372 is provided for engagement with the connecting means.

- 25 Figures 95 to 97 show a piston assembly 374 having a single vertical guide bar 376 and a T-shaped engagement bar 378 depending from the guide bar 376.

- Figures 98 to 100 show a piston assembly functionally identical to the Figure 50 to 52 embodiment except that the re-entrant slot 380 is much nearer to the piston body 382.

- 30 Figures 101 to 103 show a piston assembly 250 having two vertical guide bars 252 extending from the piston body 254. Across the bar 256 is mounted inwardly

of the bars 252 and extends horizontally. The cross bar has a diamond shaped slot 258 which receives a corresponding tongue mounted on the connecting means.

- Figures 104 to 105 show a piston assembly 260 having a piston body 262 from 5 which descends a guide bar/engagement assembly 264. This assembly 264 includes a T-shaped engagement portion 266 having a cross bar 268 which in turn defines an L-shaped slot 270 to receive an L-shaped tongue mounted on a connecting means. A vertical guide bar 272 descends from the piston body 262. Preferably the guide bar 272 is integral with the engagement portion 266 but it 10 may be separate. The guide bar 272 preferably extends below the horizontal cross bar 268.

Figures 107 to 109 show a piston assembly 274 having a piston body 276 and a 15 guide/engagement assembly 278 pivotably mounted to the body 276 by gudgeon pin 280. The assembly 278 has a T-shaped portion comprising vertical leg 282 and horizontal cross bar 284. The cross bar has a T-shaped slot 286 in a side wall 288 for receiving a corresponding tongue on the connecting means.

Figures 110 to 112 show a piston assembly 290 having a piston body 292 with four vertical and parallel guide bars 294 extending downwards. The four bars 294 are located at the corners of a square centred on the centre of the piston's 20 circumference.

An engagement means 296 is pivotably mounted on the piston via gudgeon pin 298 and is located between the vertical guide bars 294. The engagement means includes a flat cross bar 300 which may engage in a T-shaped slot on the connecting means.

- 25 Figures 113 to 115 show a piston assembly 302 having a piston body 304 with a guide/engagement assembly 306 attached to the body 304 by two pins 308. The assembly 306 has a vertical post 310 and a first cross bar 312 having four vertical guide posts 314, each arranged at one of its corners. Mounted to the underside of the first cross bar 312 is a second T-shaped cross bar 316 which is 30 engaged by a corresponding T-shaped slot on the connecting means.

It will be apparent that many modifications and variations may be made to the embodiments described by those skilled in the art without departing from the spirit or scope of the invention.

Dated this 11th day of August, 1999

Peter and Michael Raffaele

By their Patent Attorneys

Chrysiliou Moore Martin

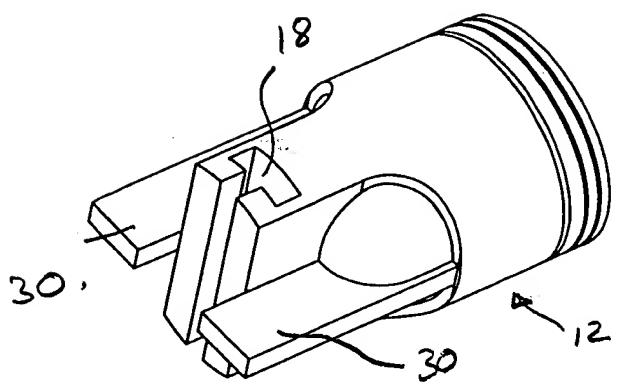


Figure 2

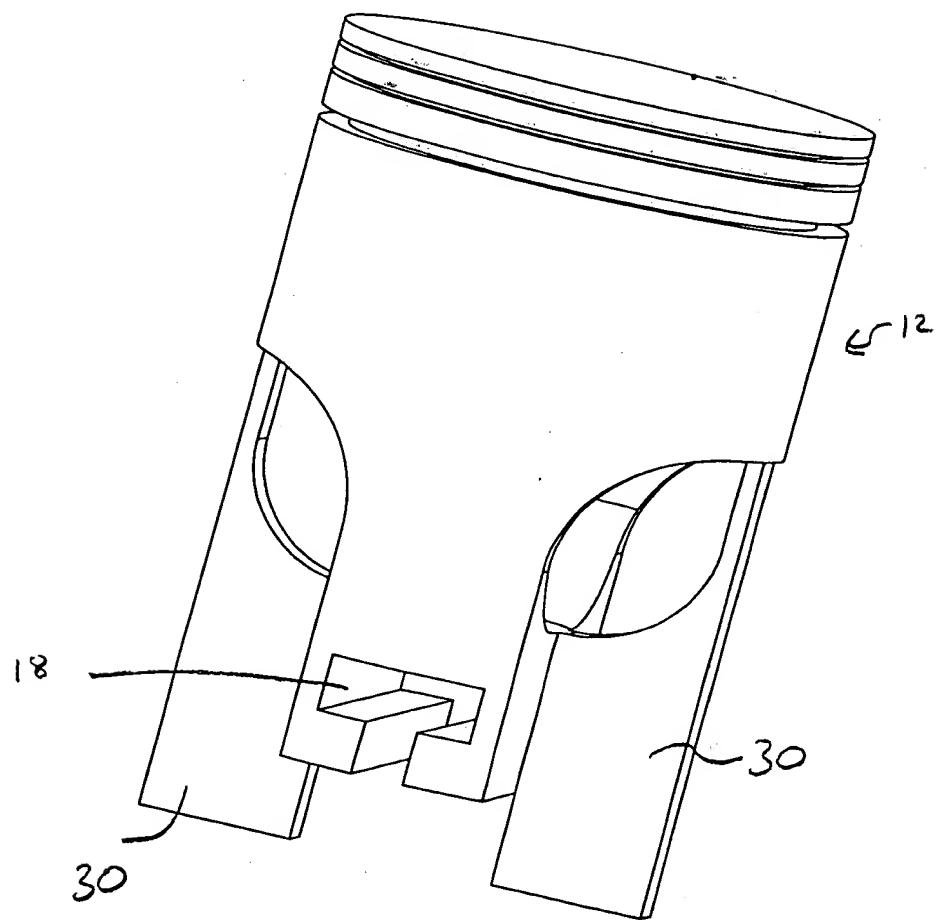


Figure 2

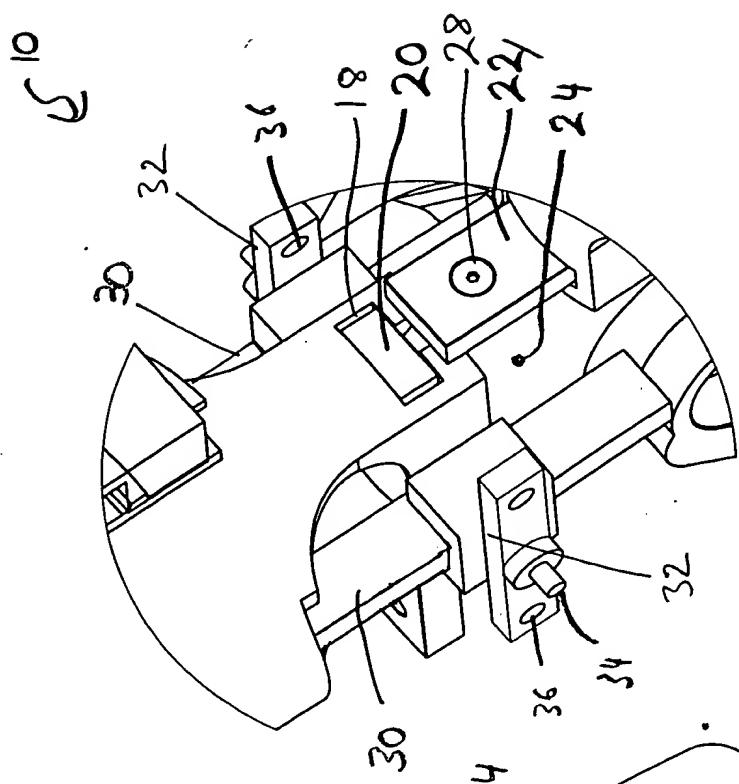


Figure 4

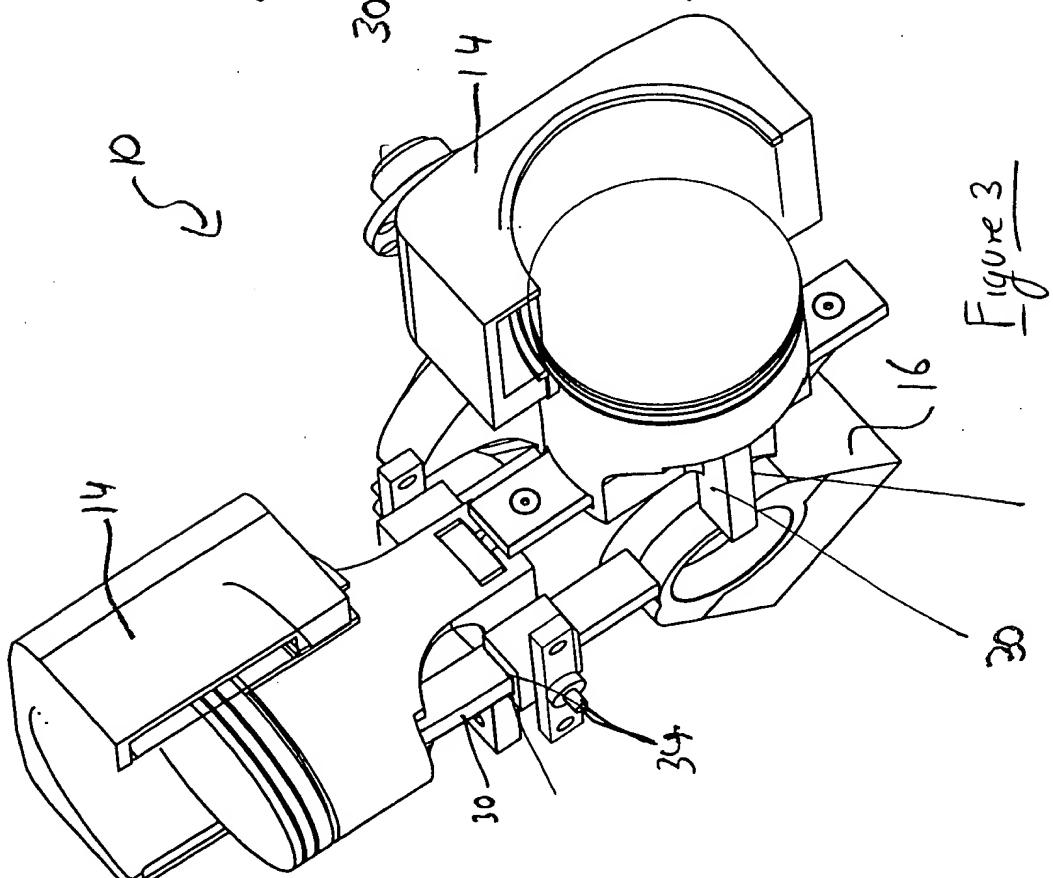


Figure 3

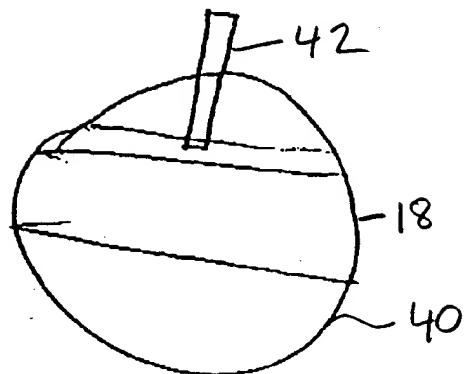


Figure 5

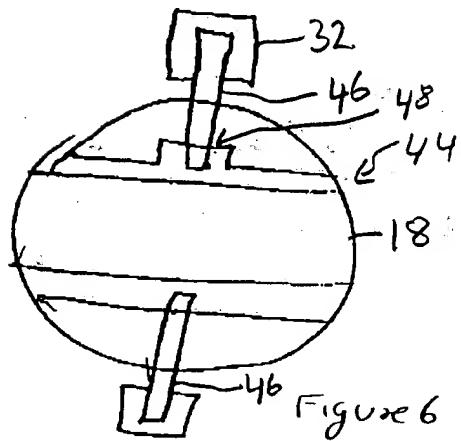


Figure 6

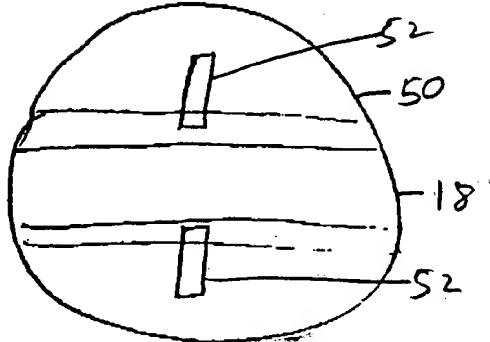


Figure 7

Figure 8

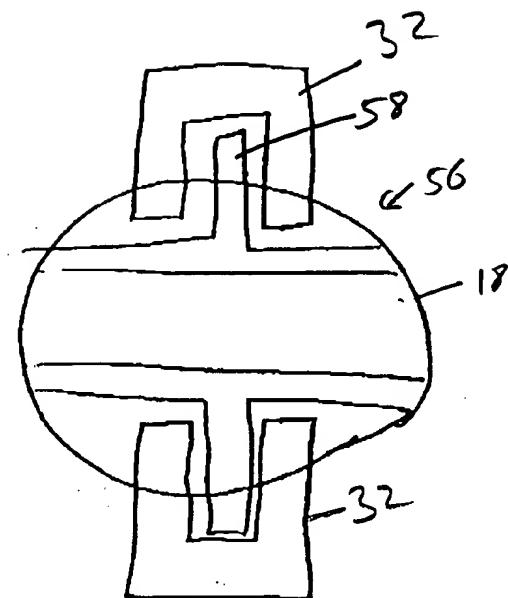


Figure 9

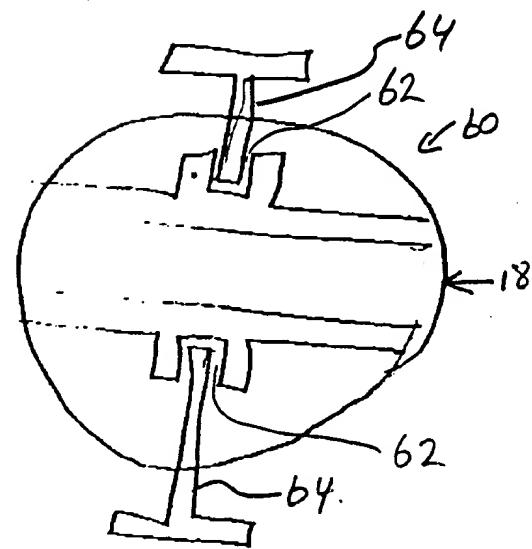
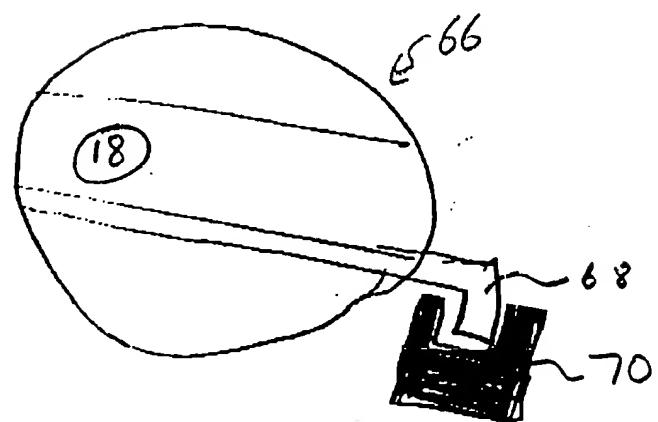


Figure 10.



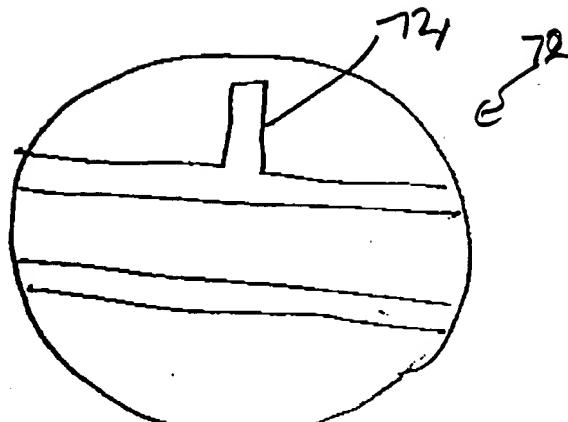


Figure 11

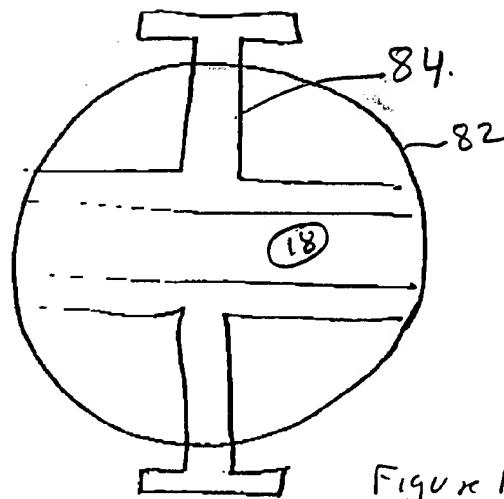


Figure 14

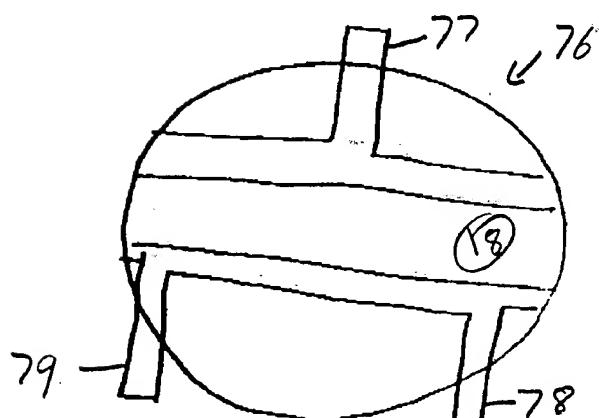


Figure 12

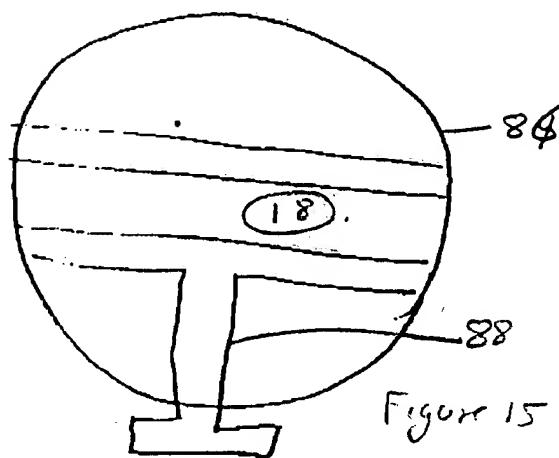


Figure 15

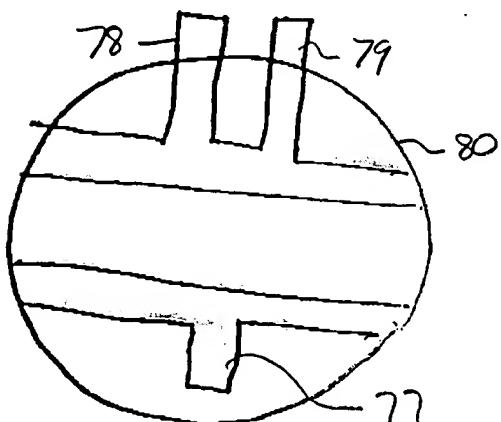


Figure 13

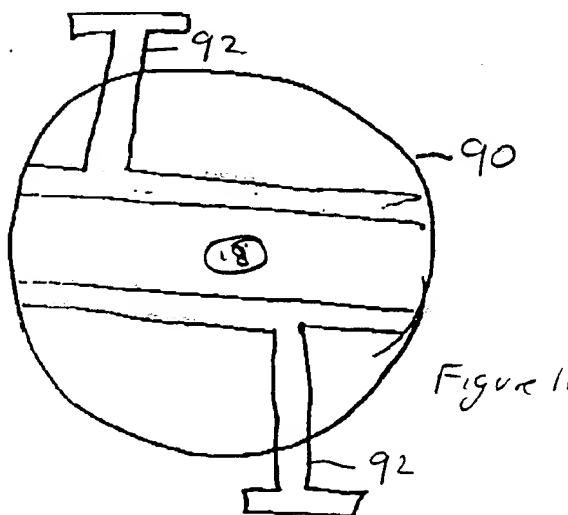


Figure 16

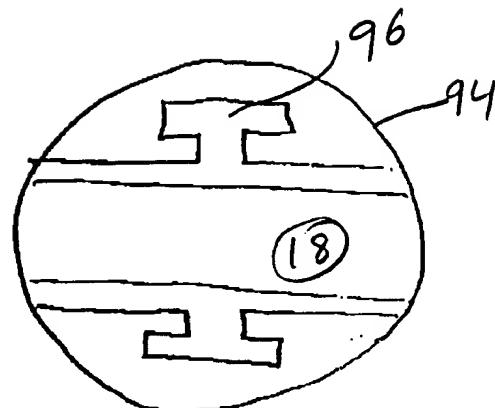


Figure 17

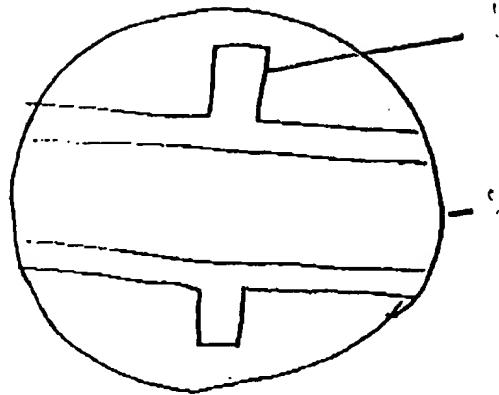


Figure 20

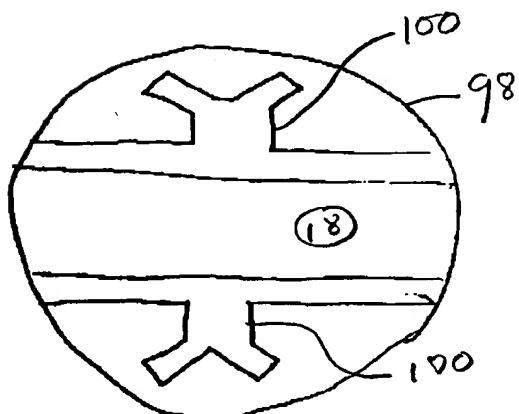


Figure 18

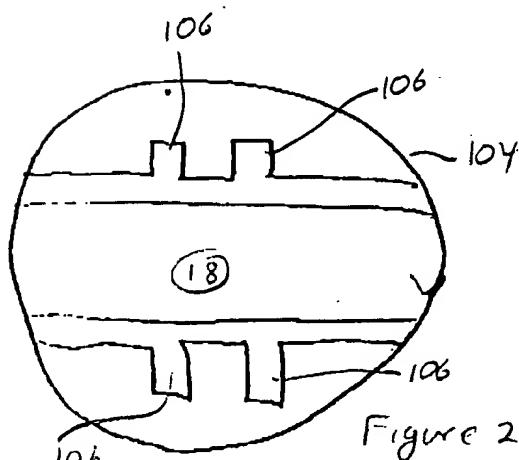


Figure 21

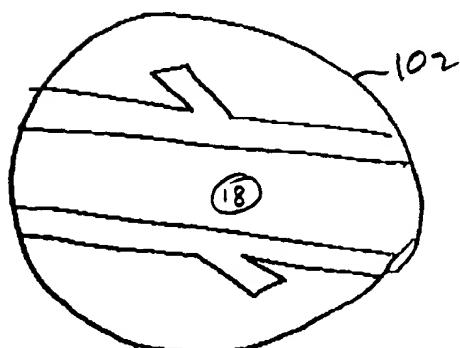


Figure 19

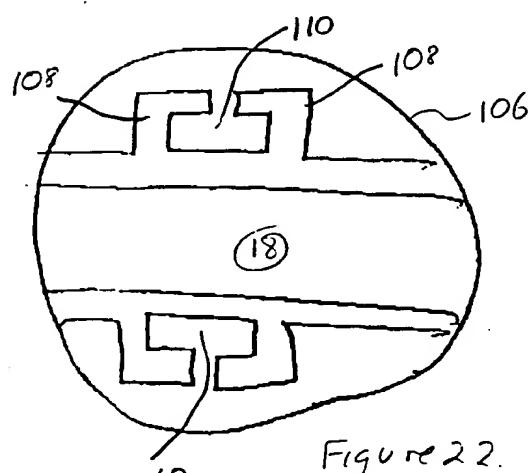


Figure 22.

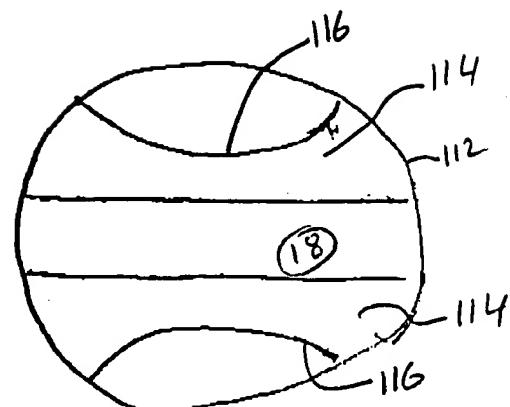


Figure 23

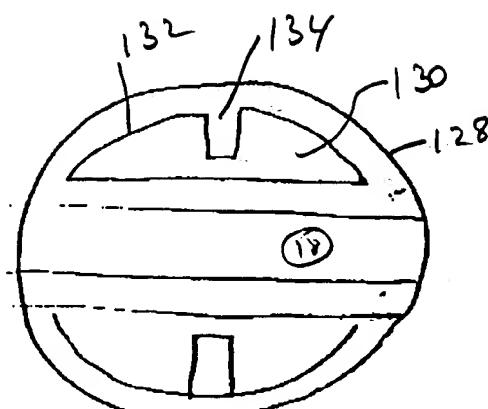


Figure 26

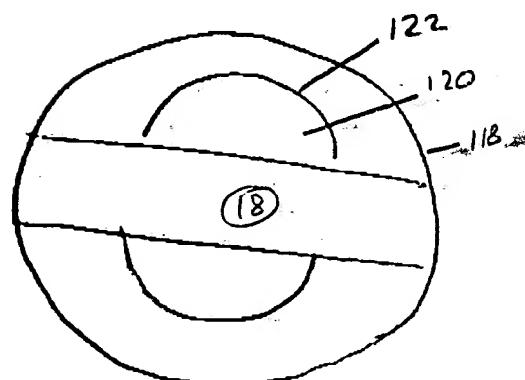


Figure 24

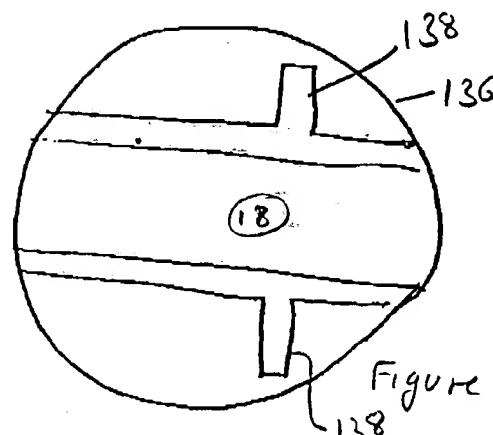


Figure 27

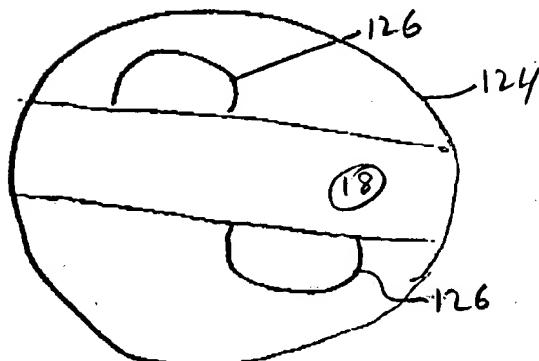


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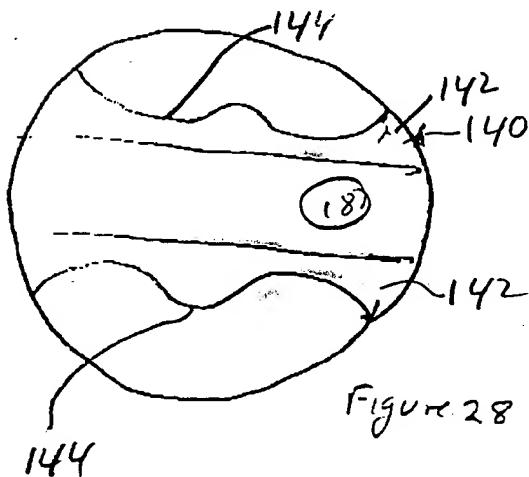


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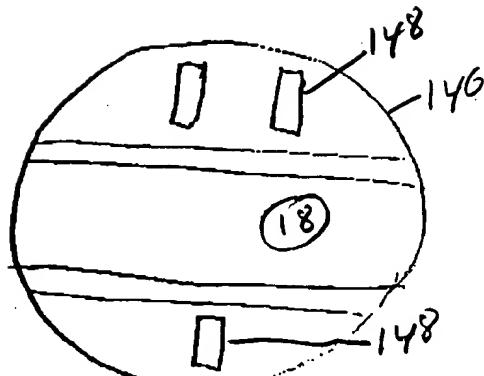


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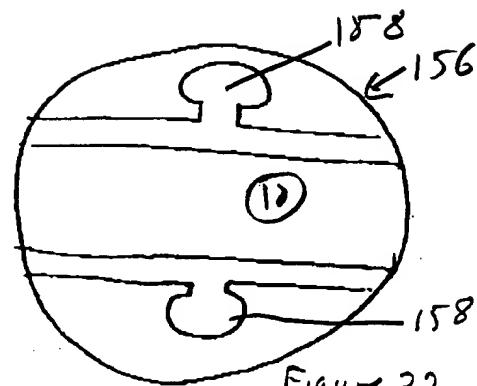


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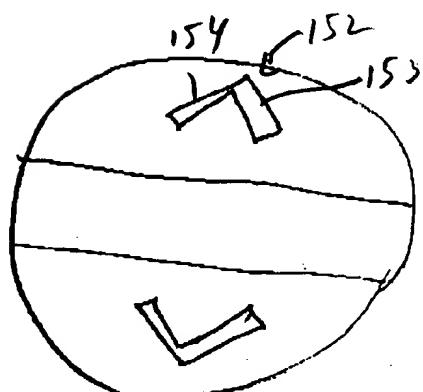


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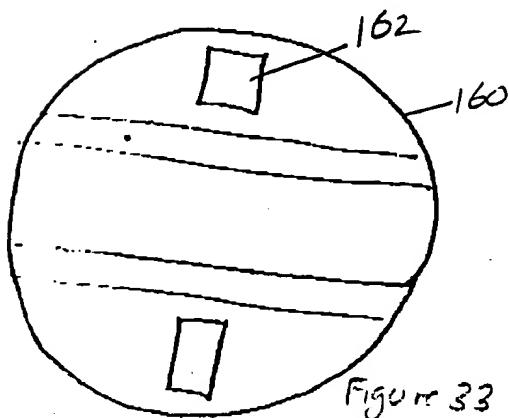


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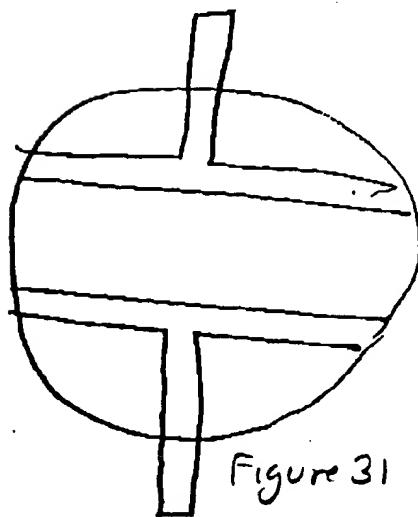


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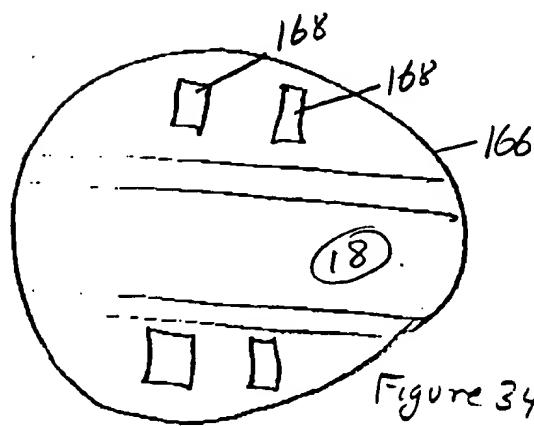


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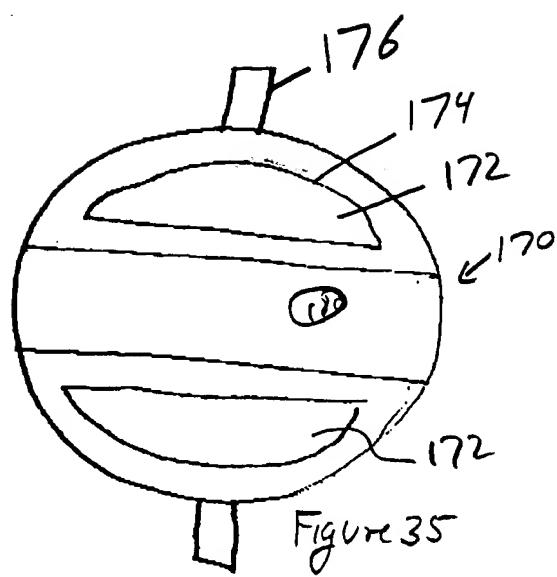


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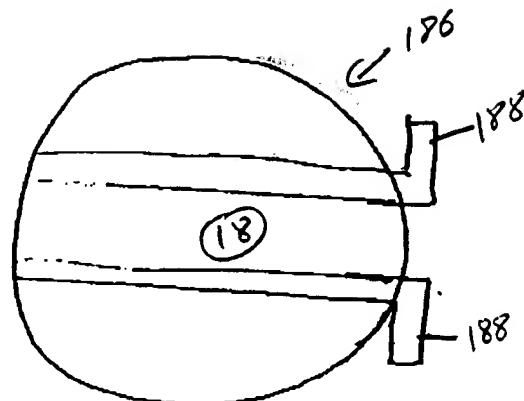


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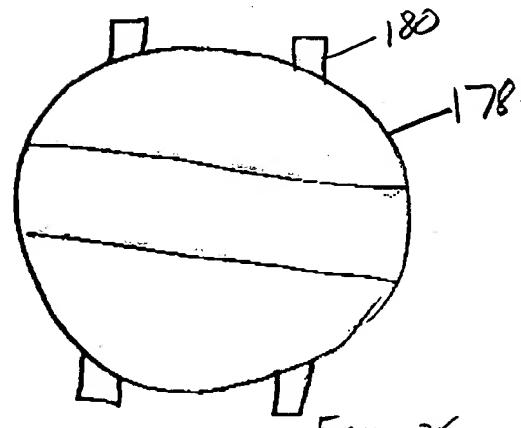


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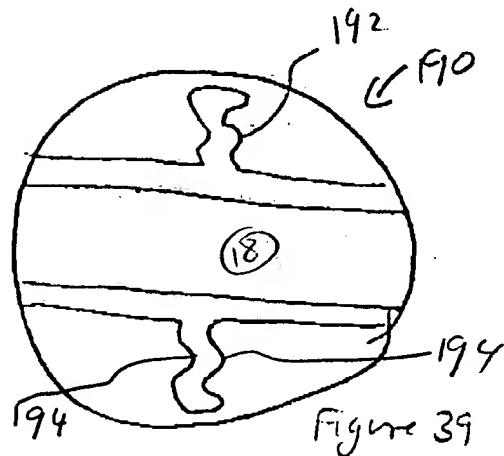


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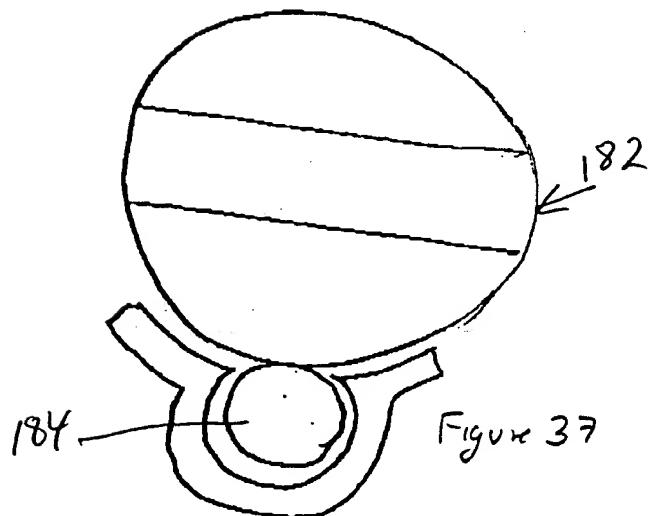


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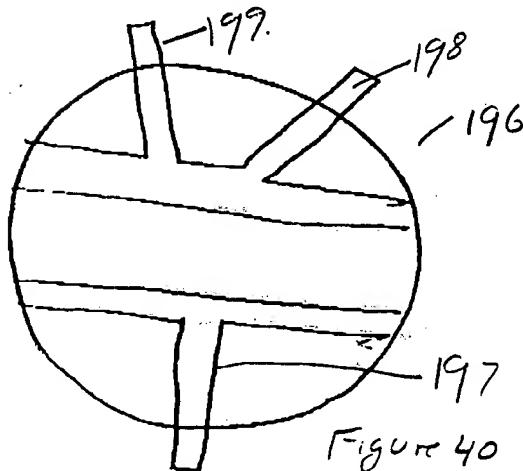


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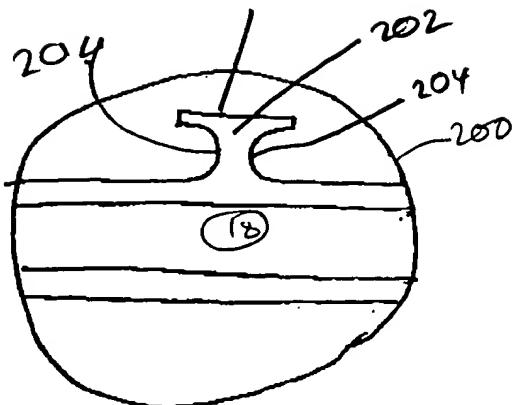


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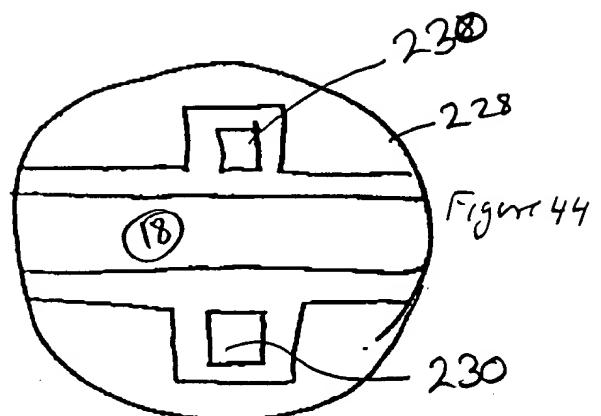


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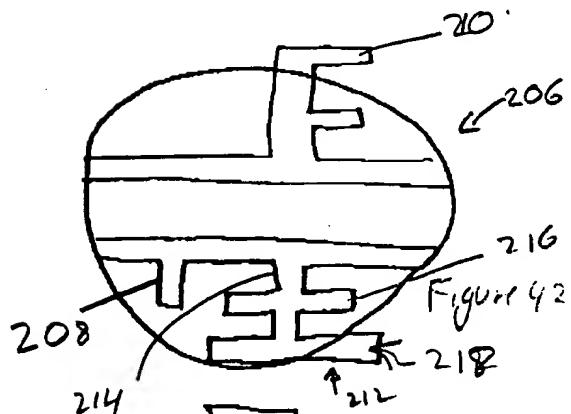


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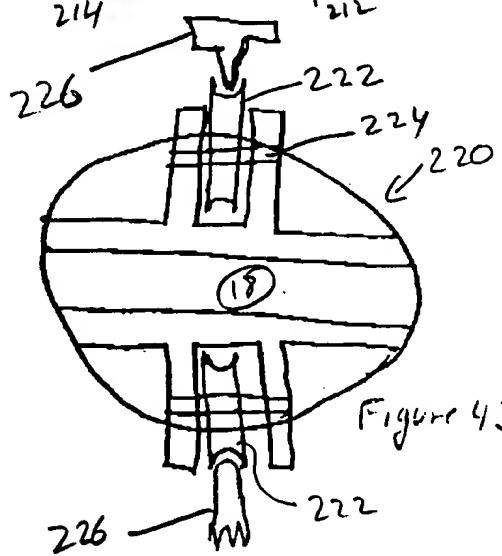


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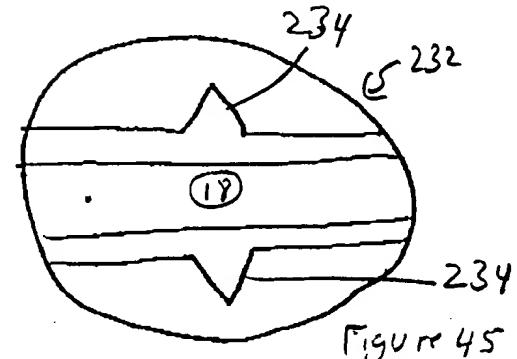


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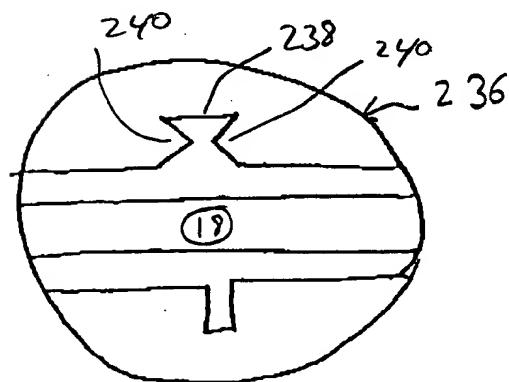


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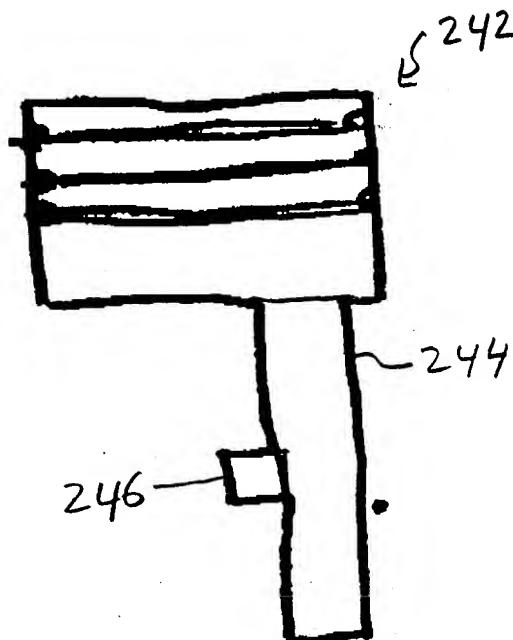


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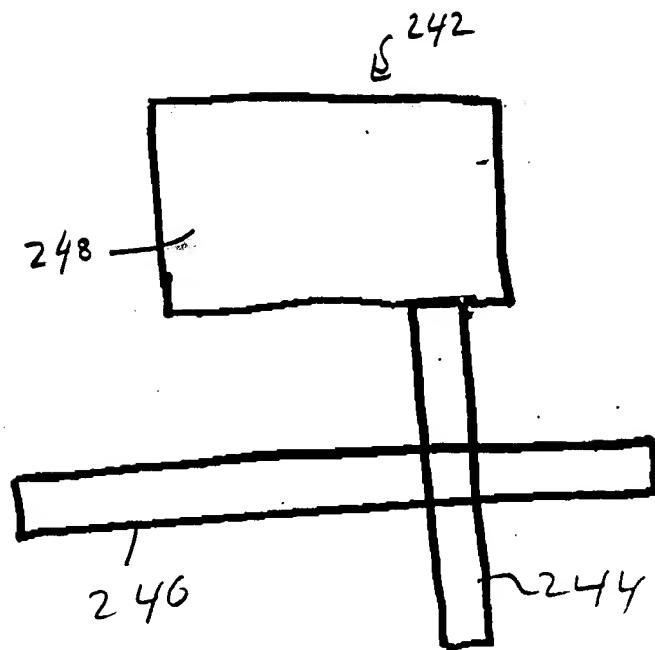


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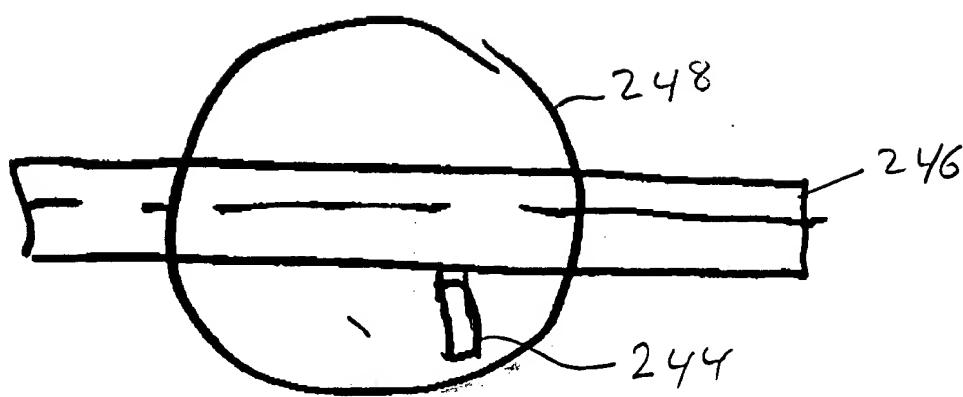


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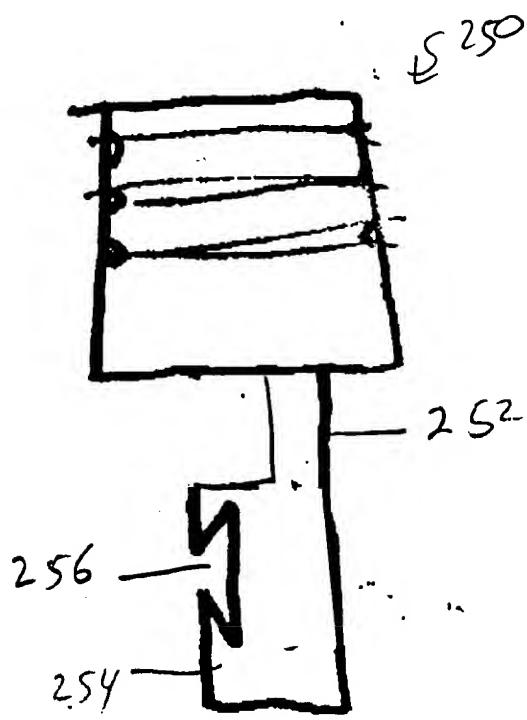


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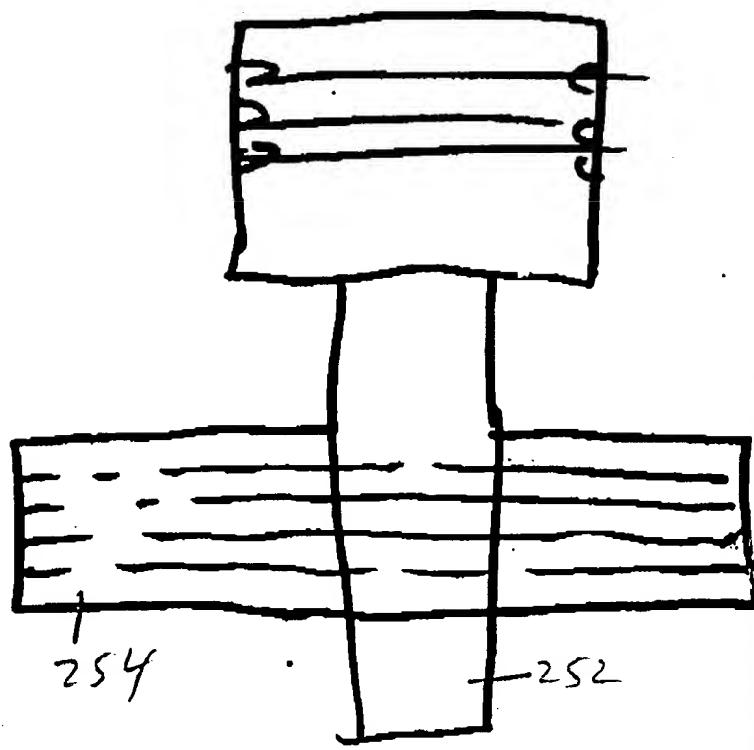


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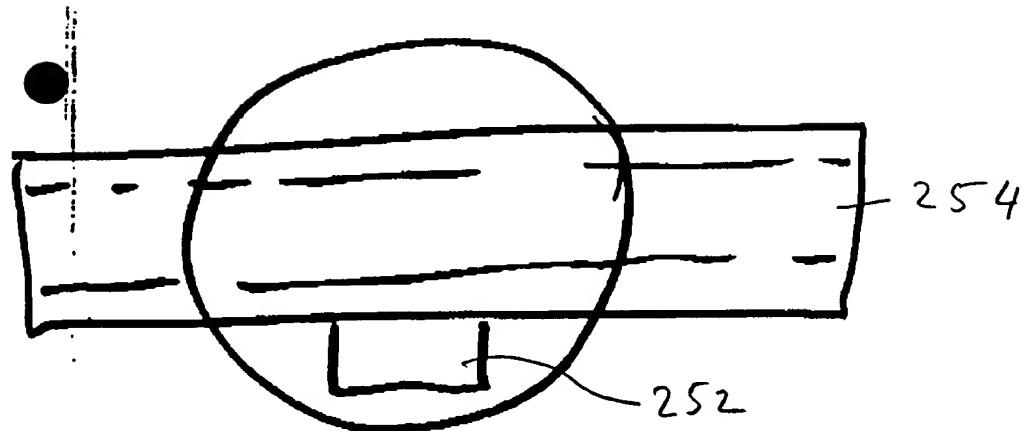


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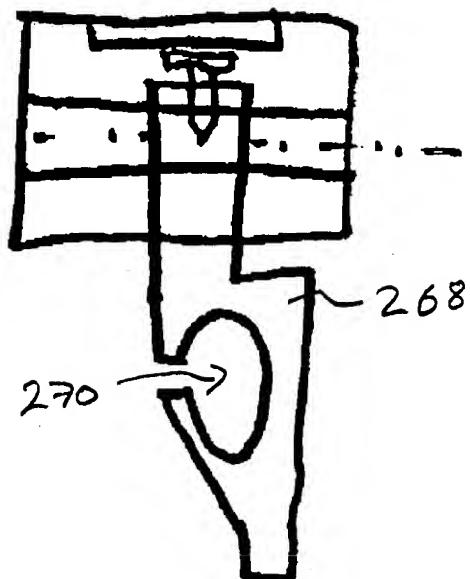


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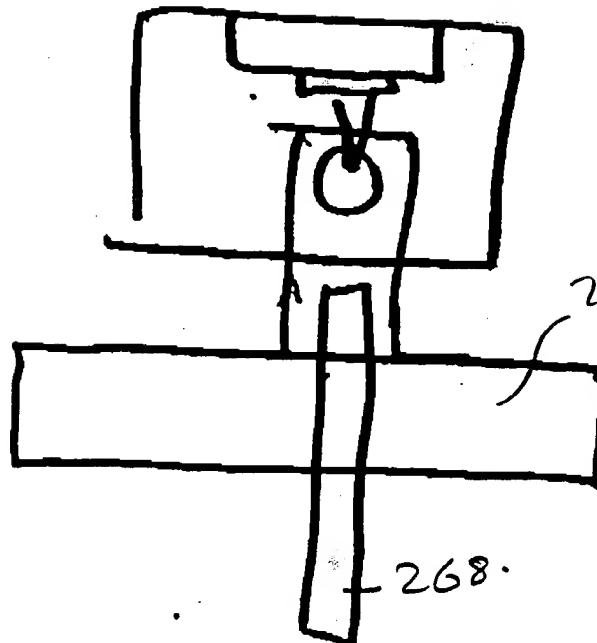


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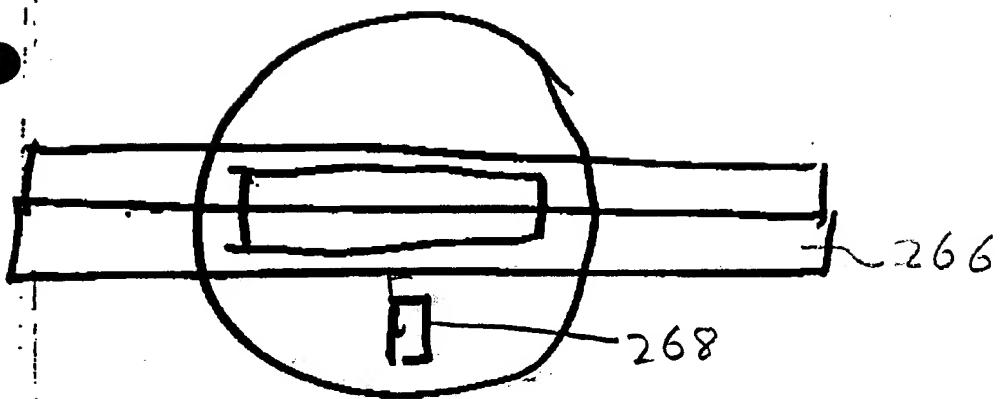


Figure 55

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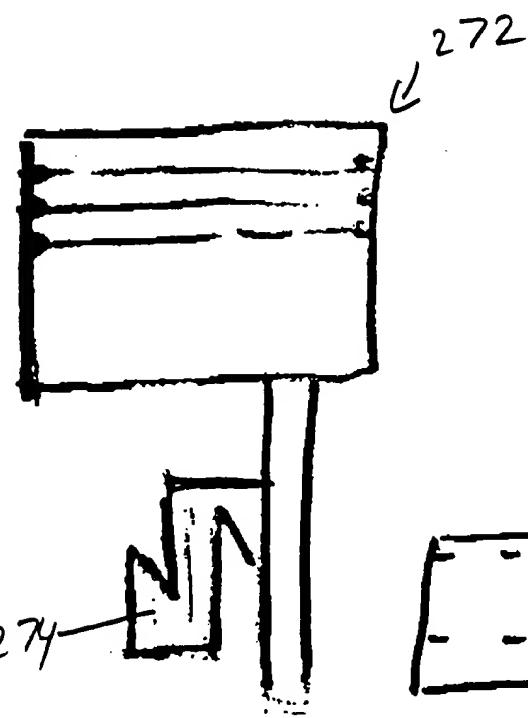


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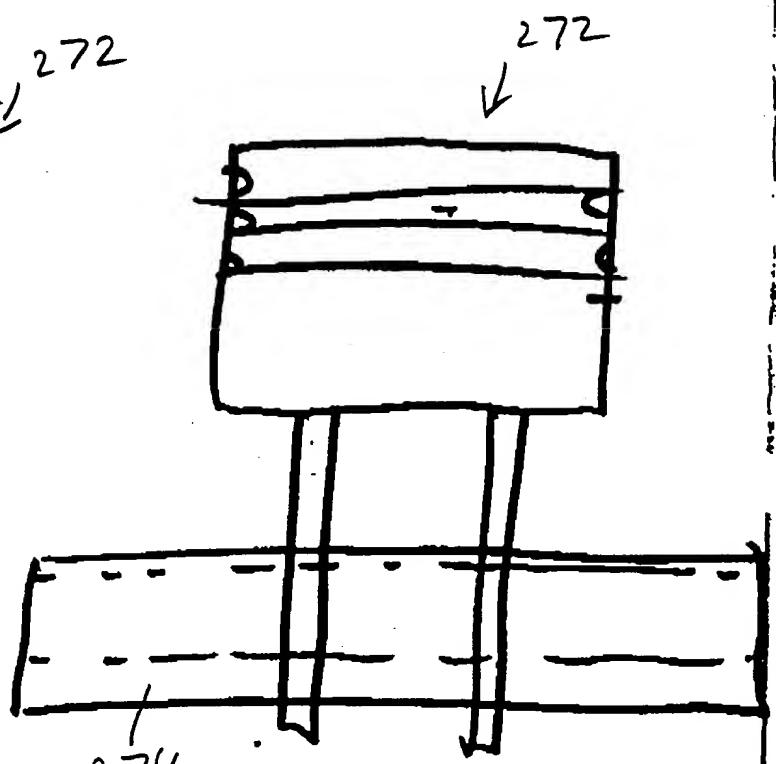


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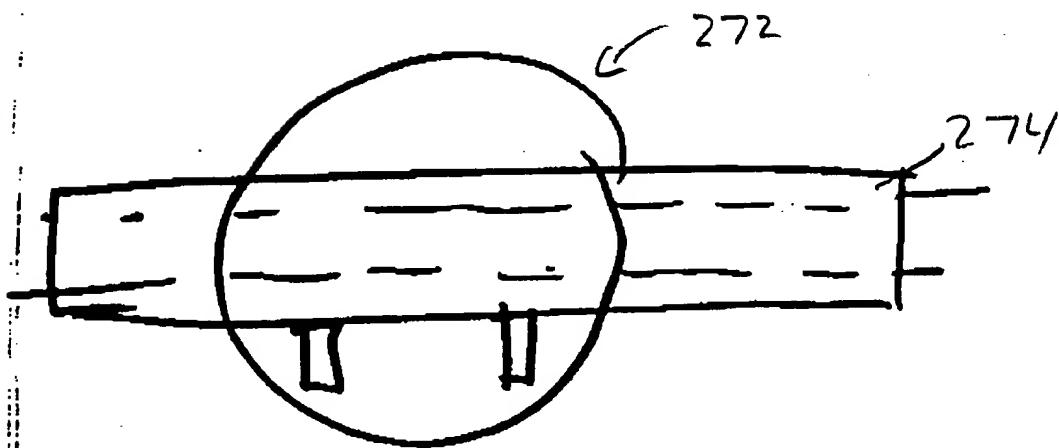


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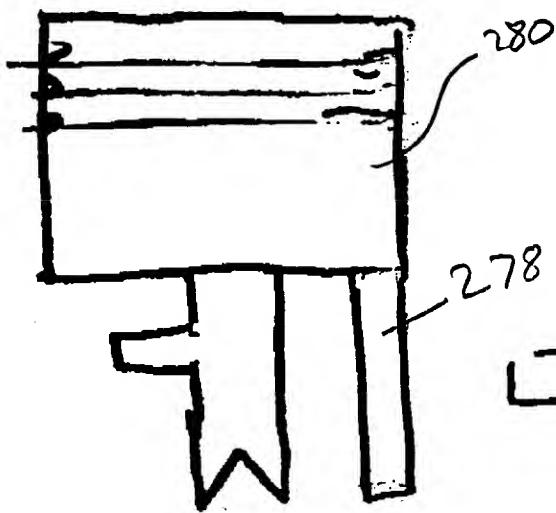


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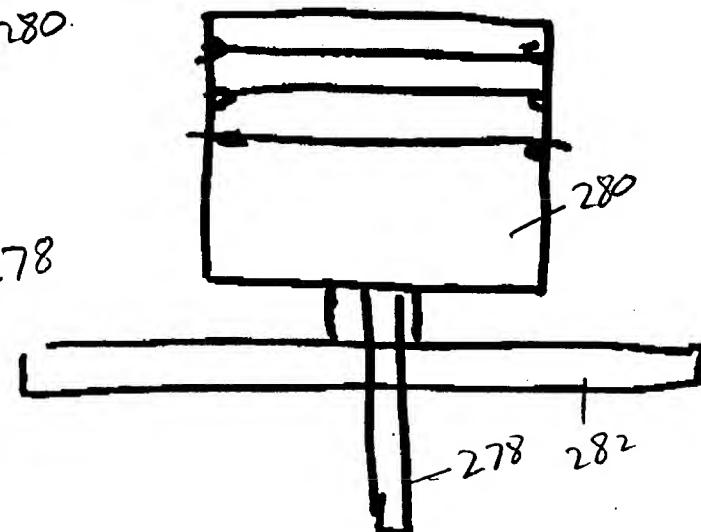


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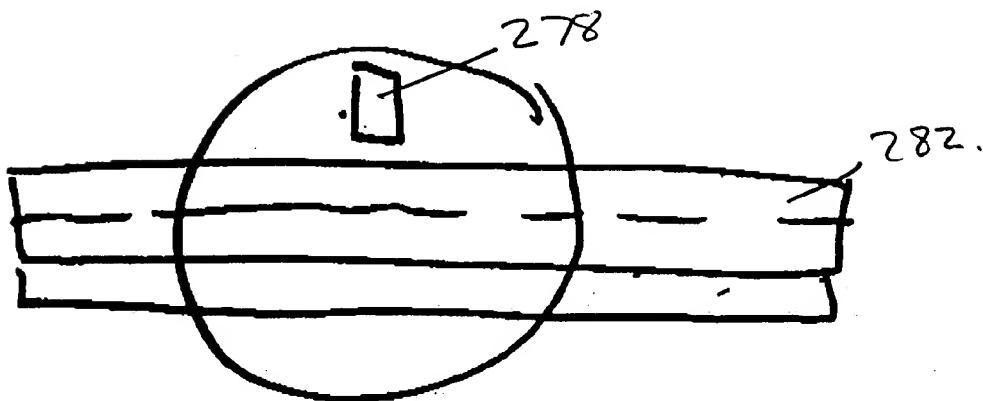


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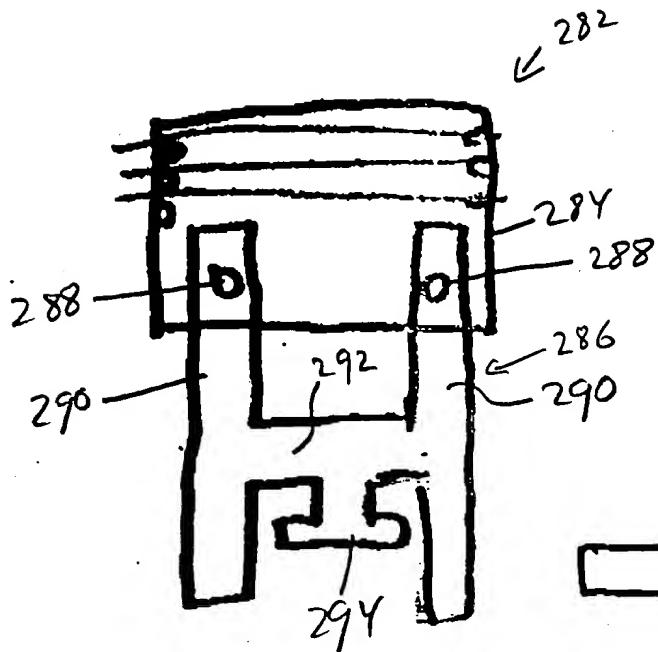


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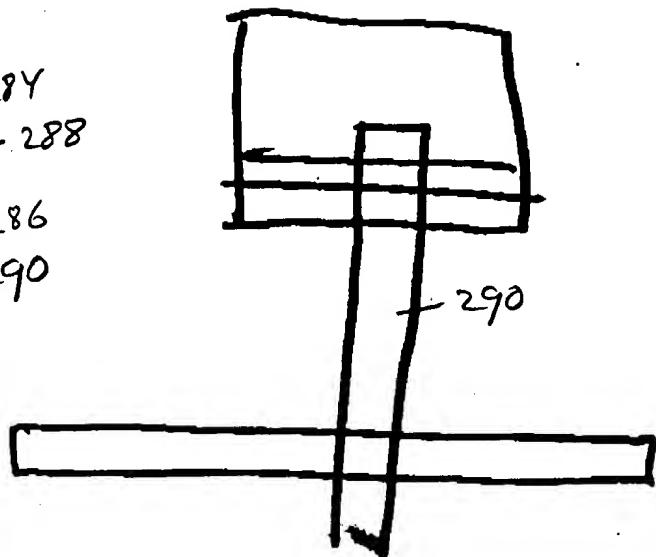


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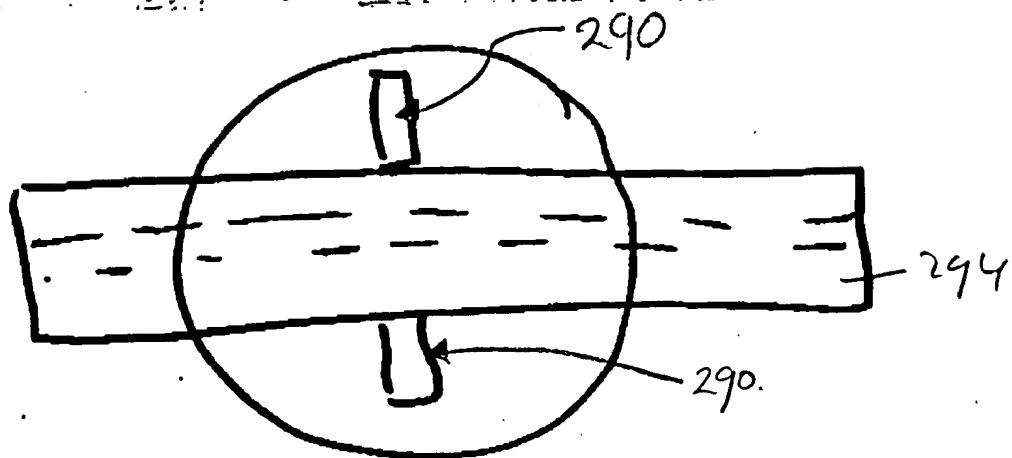


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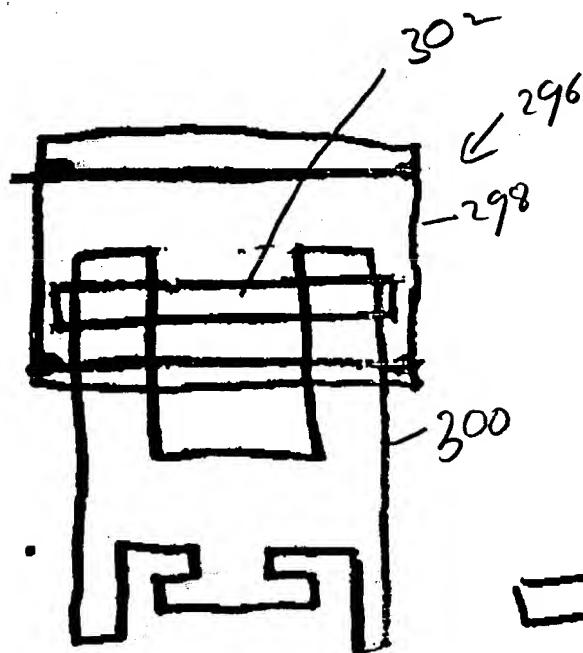


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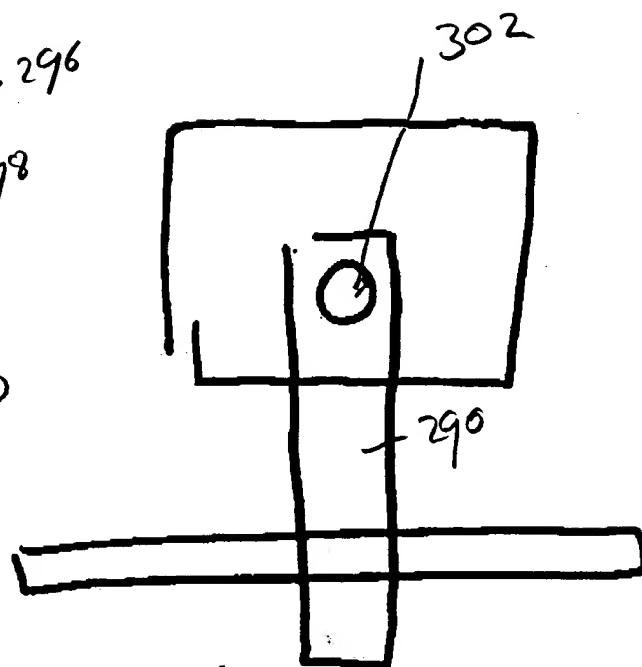


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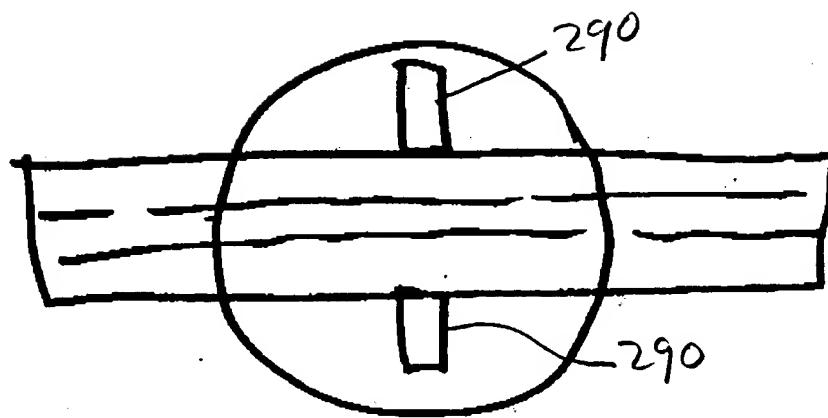


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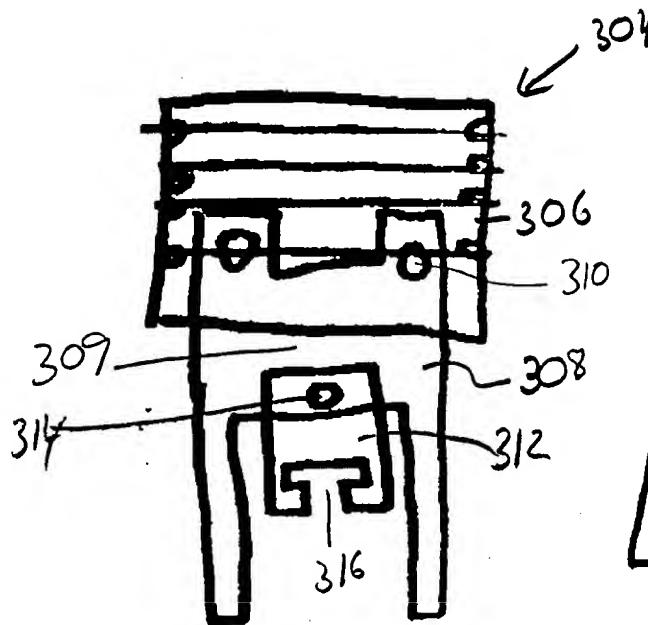


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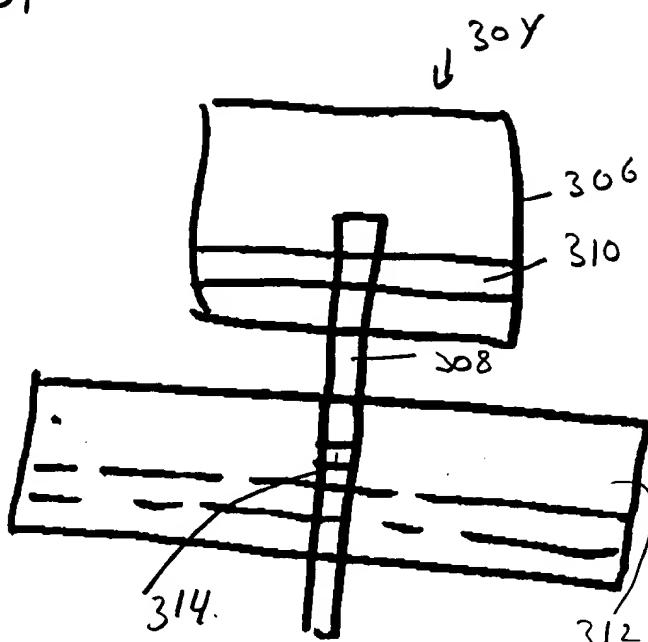


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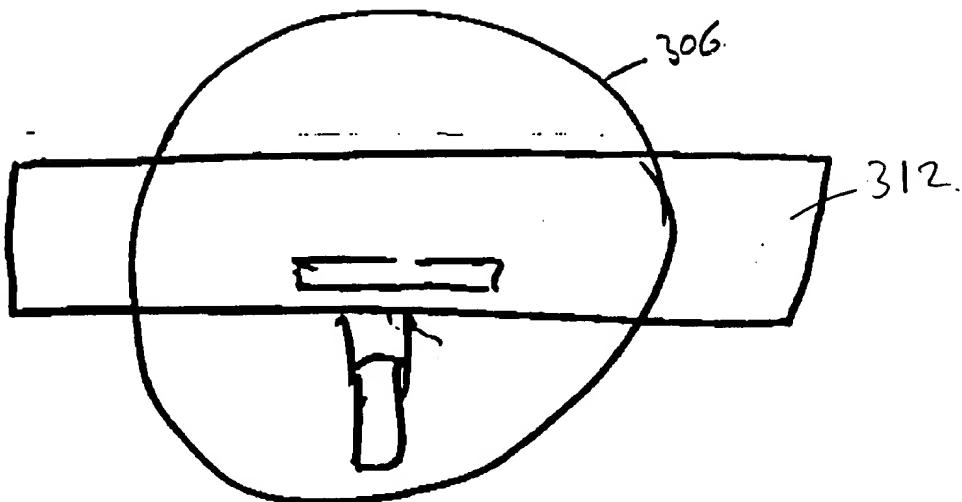


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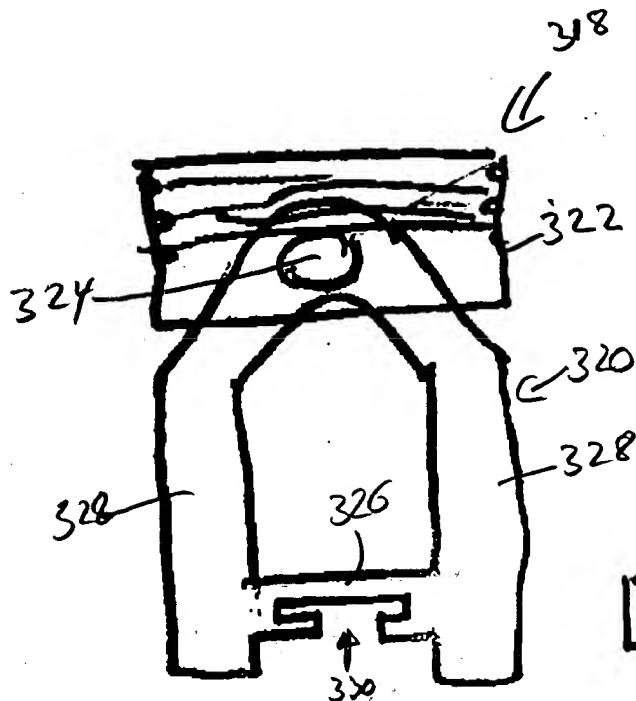


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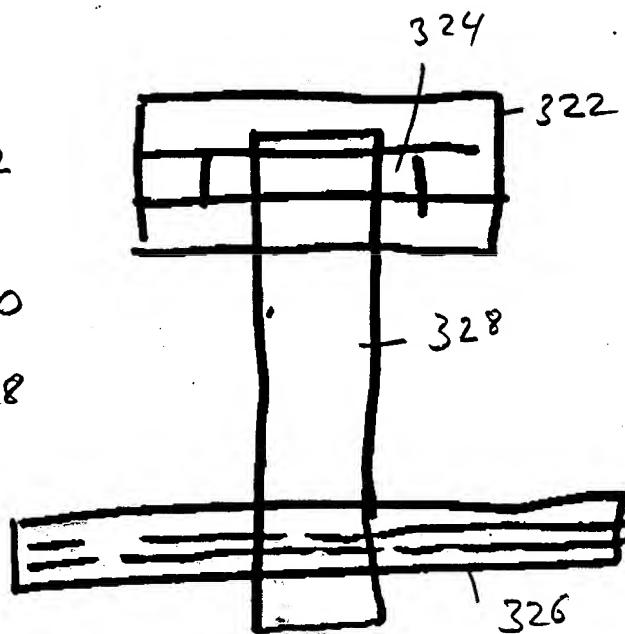


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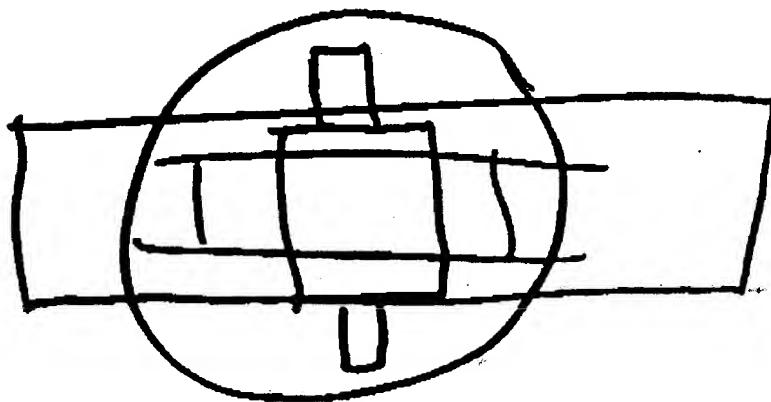


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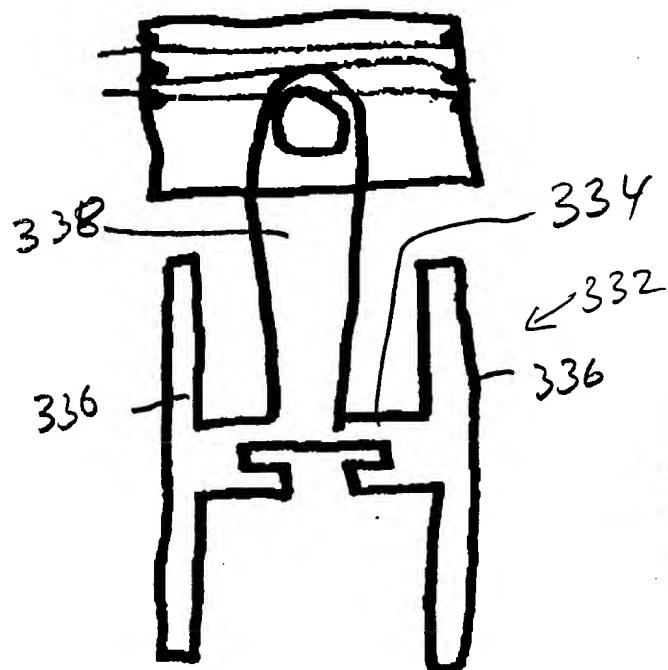


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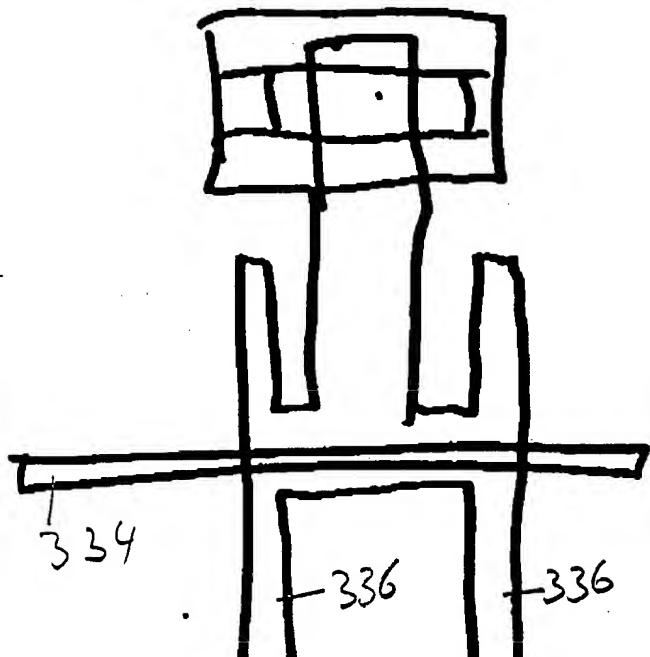


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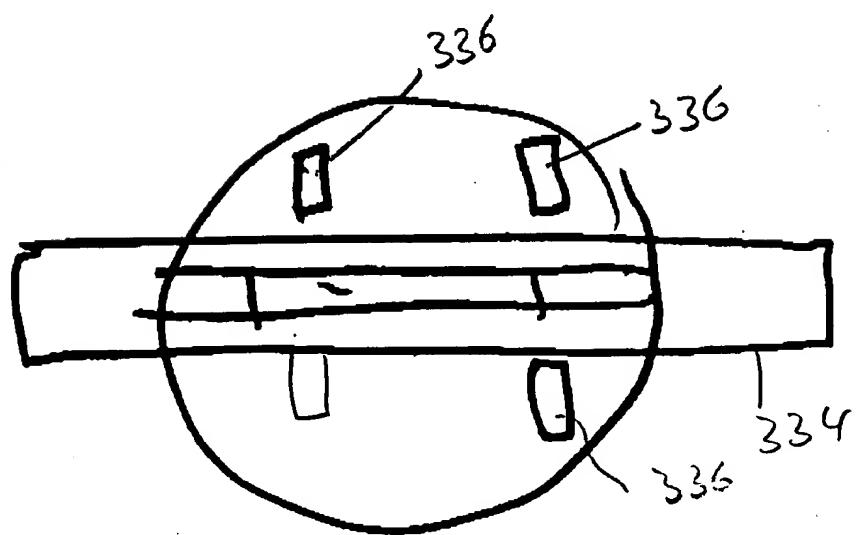


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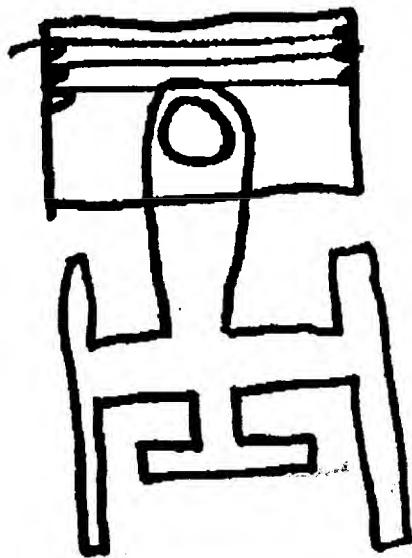


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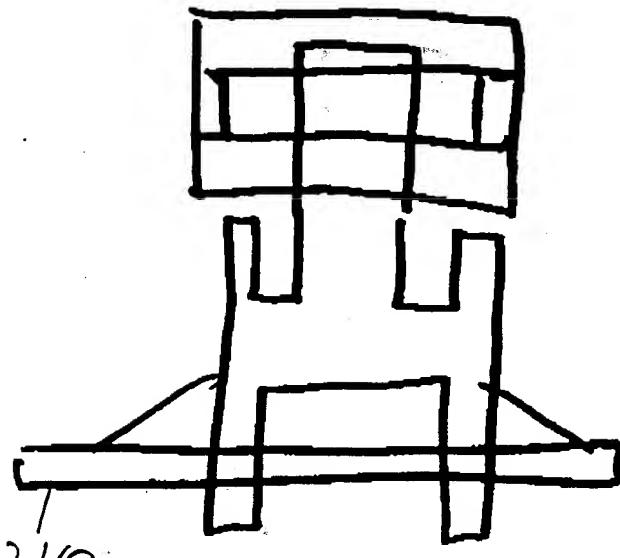


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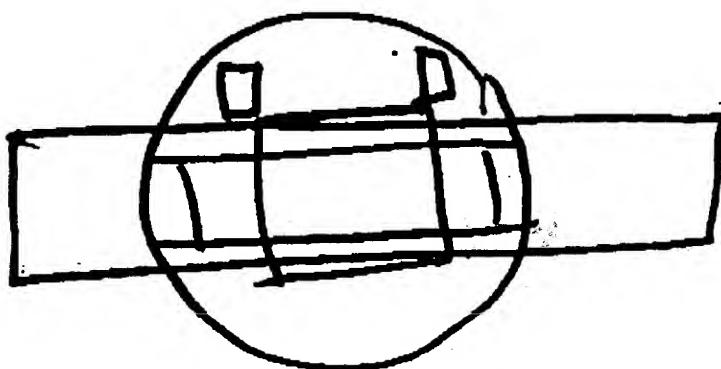


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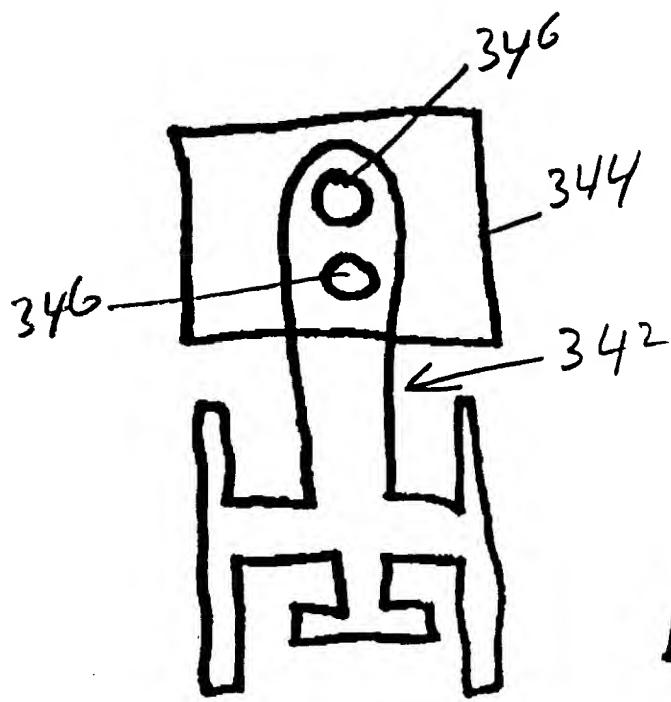


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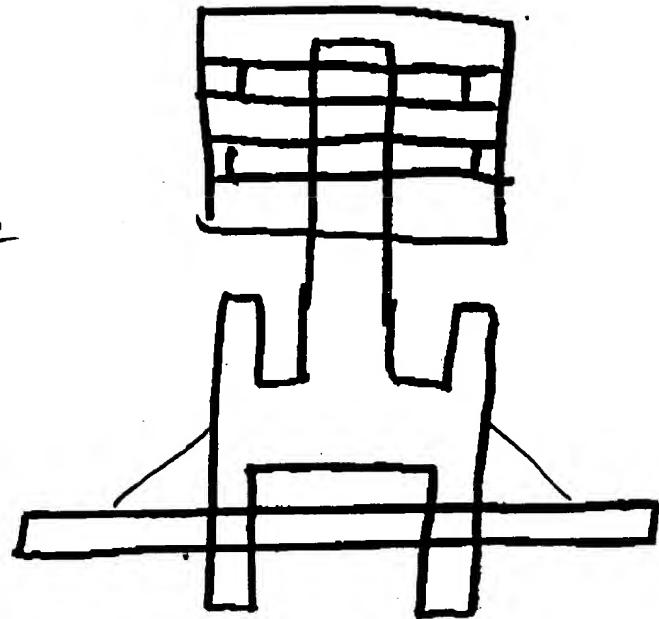


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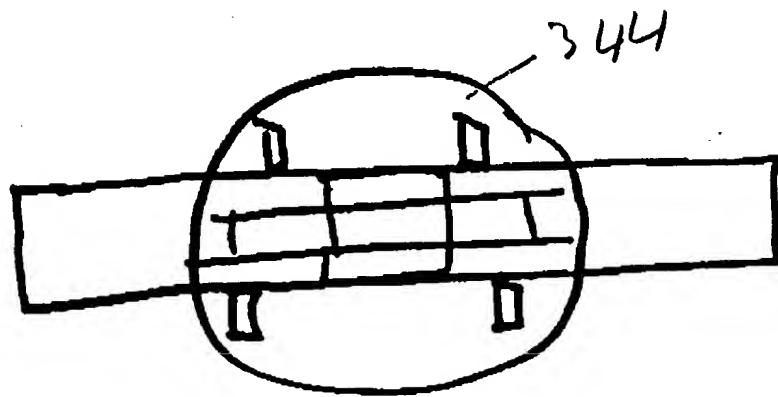


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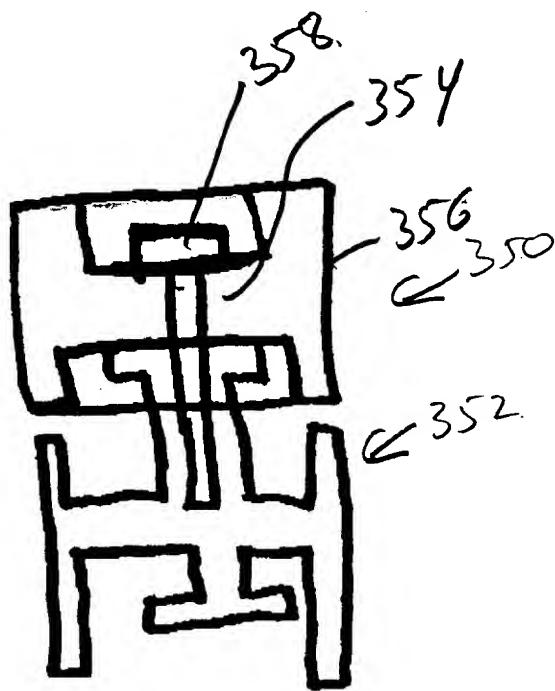


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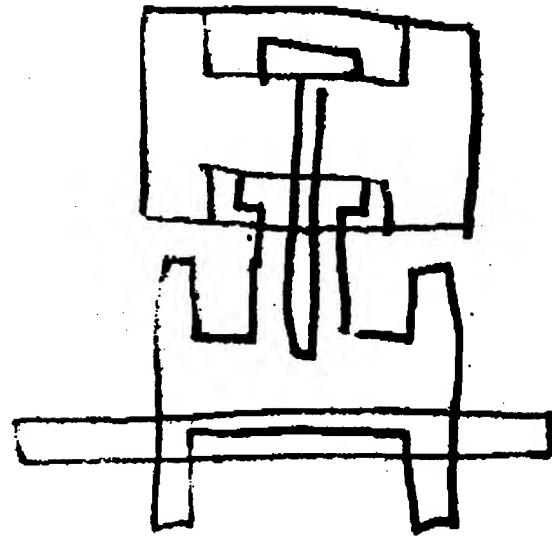


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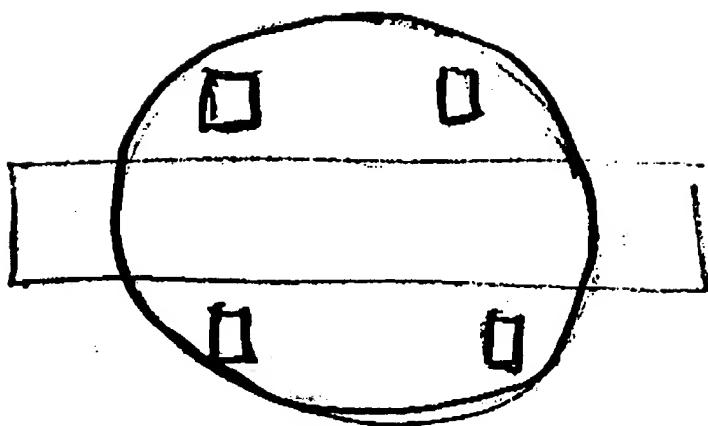


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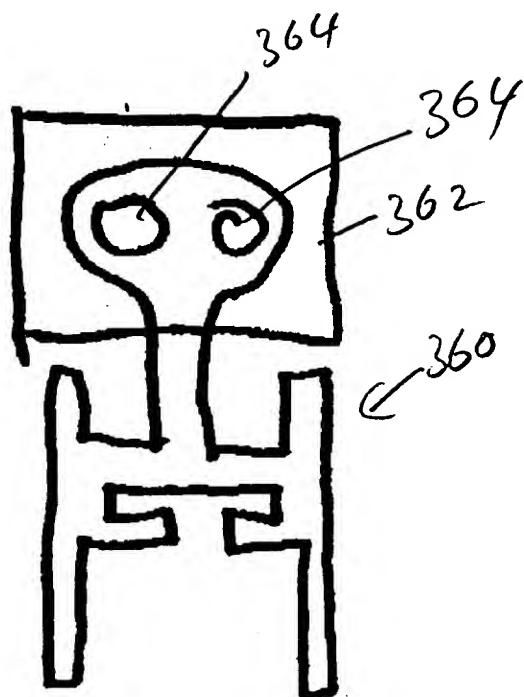


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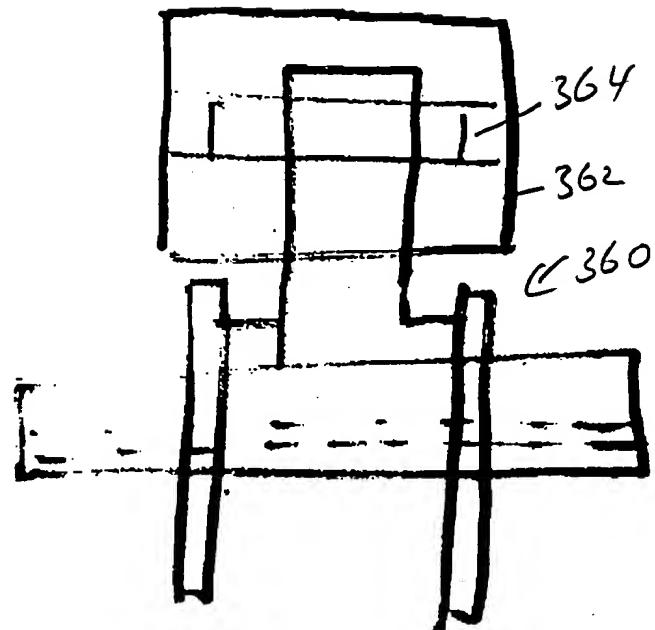


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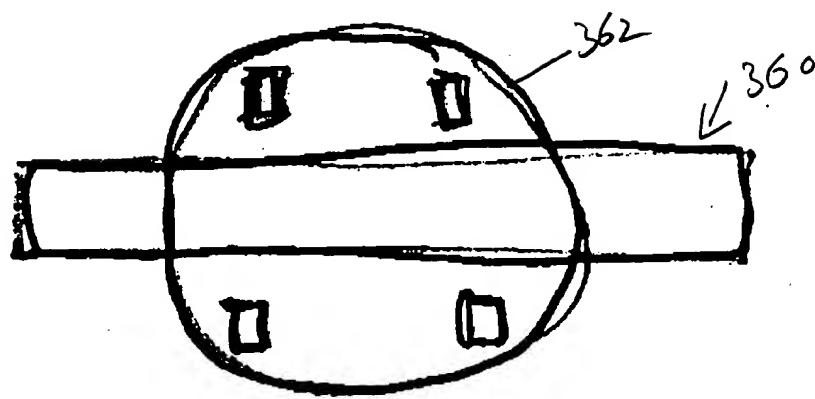


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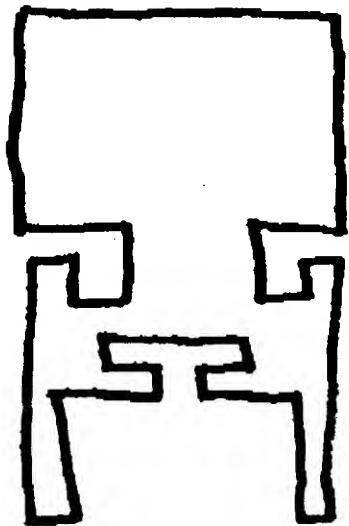


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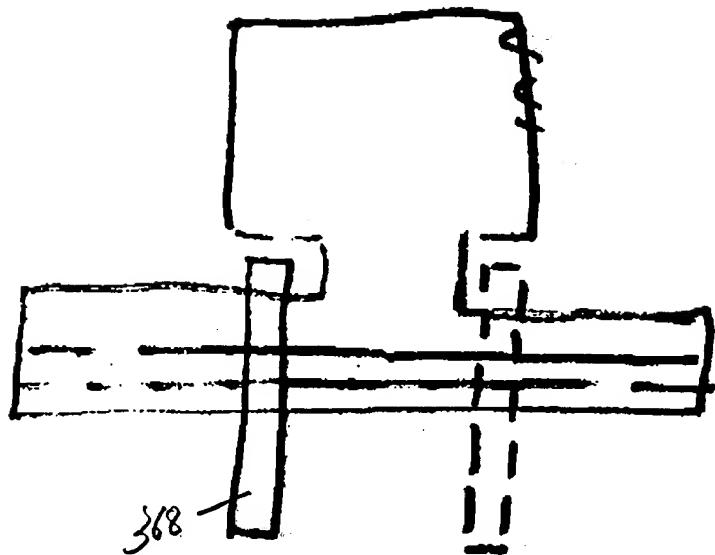


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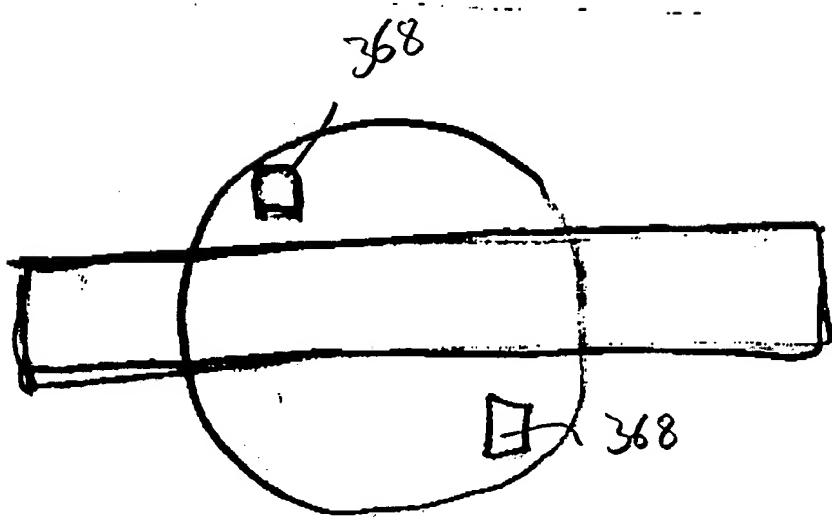


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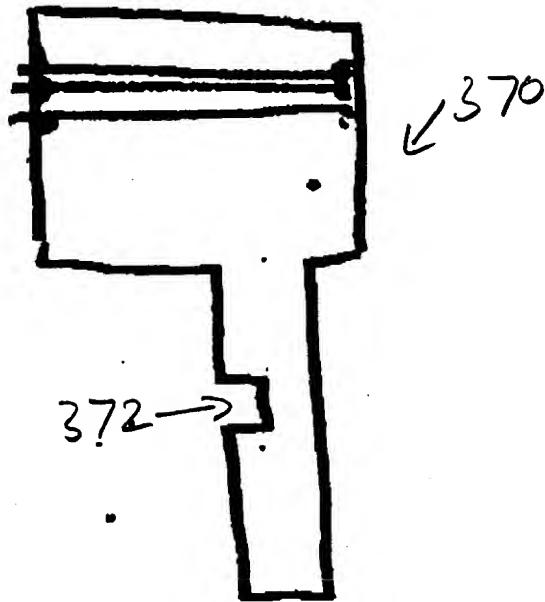


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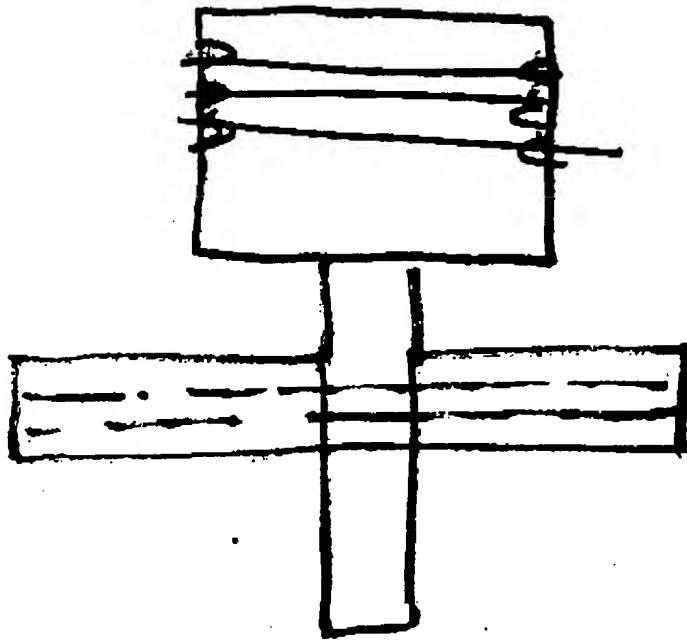


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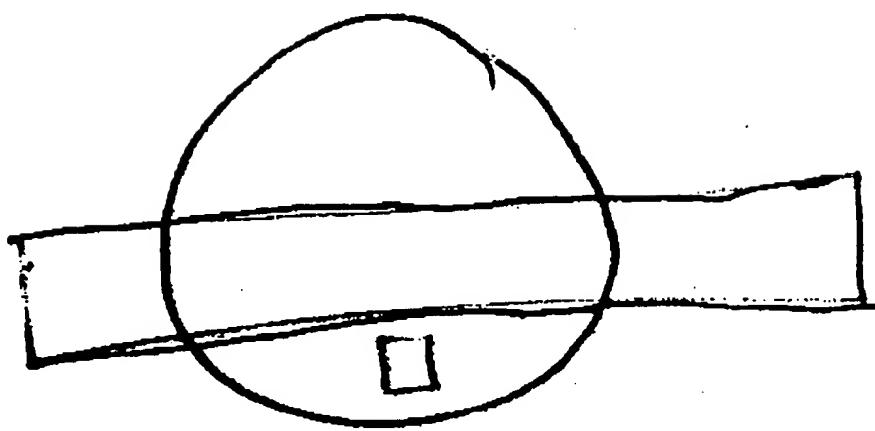


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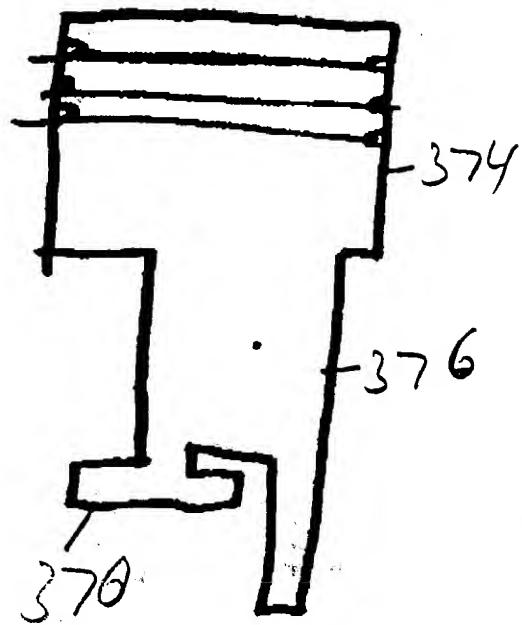


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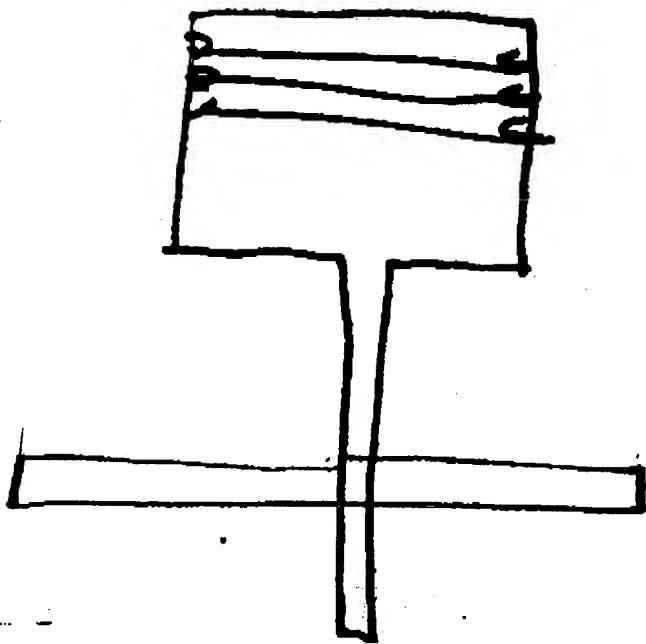


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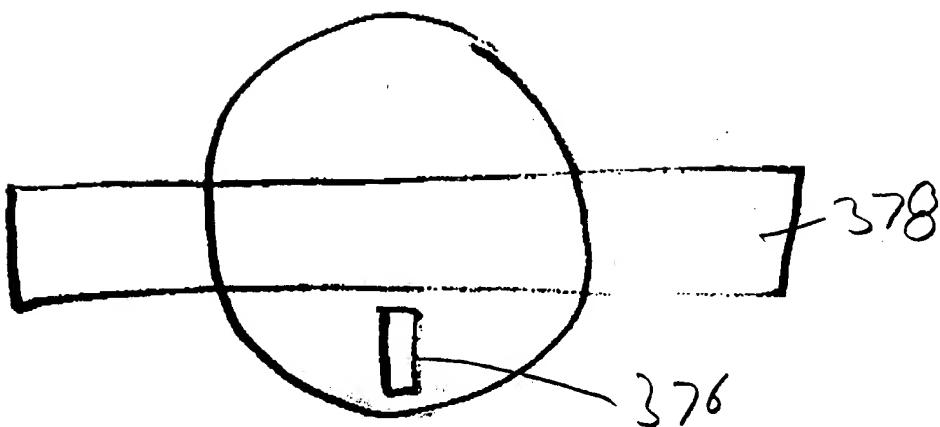


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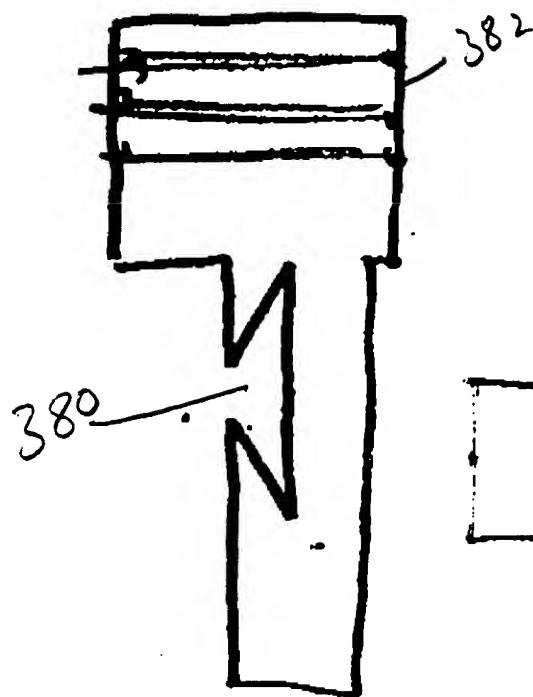


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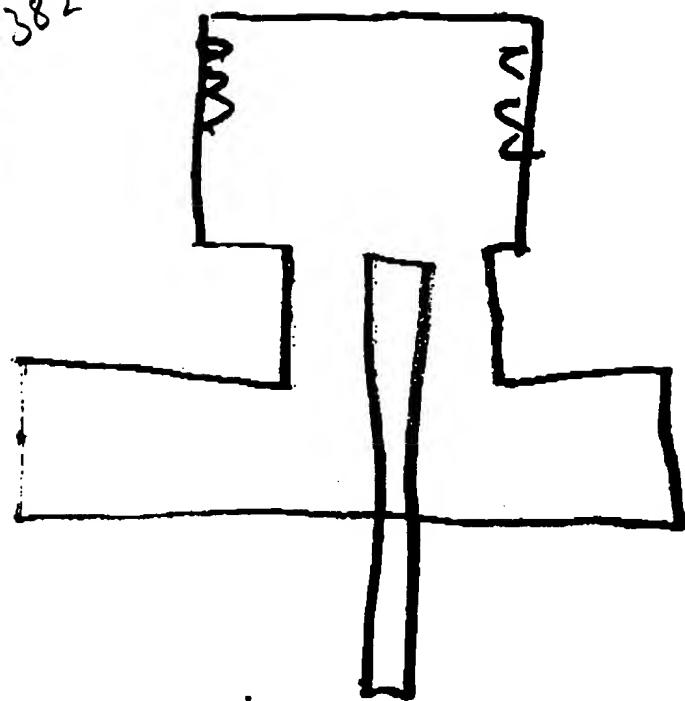


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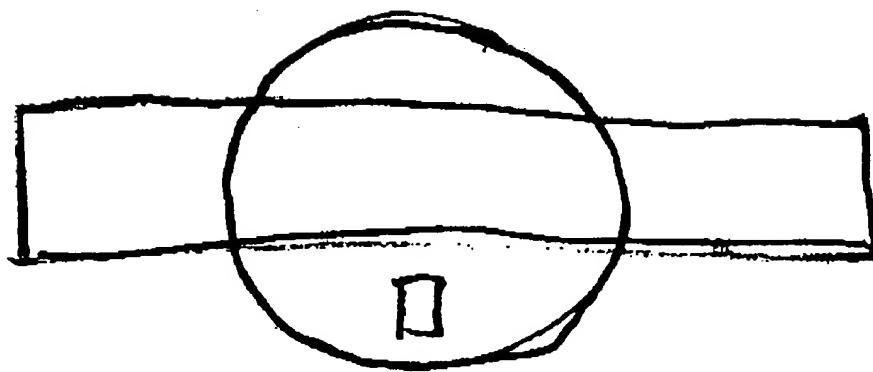


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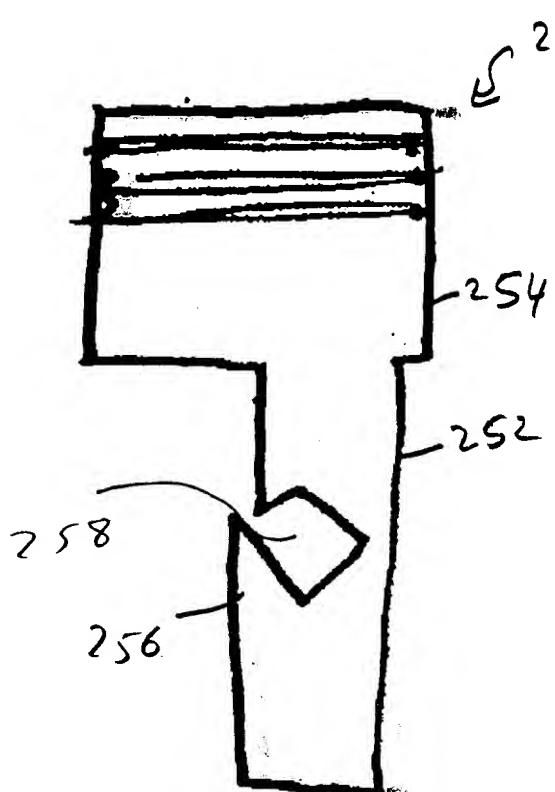


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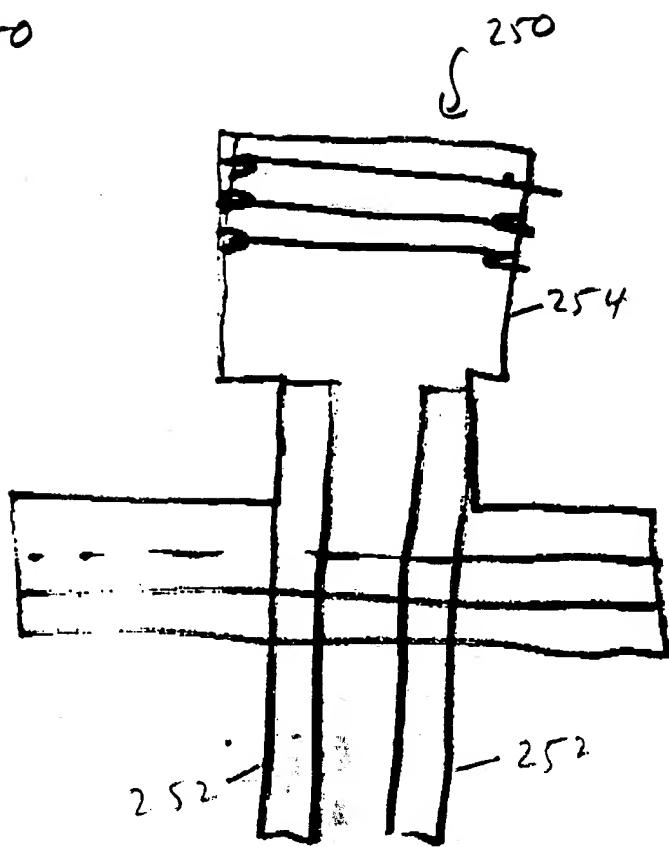


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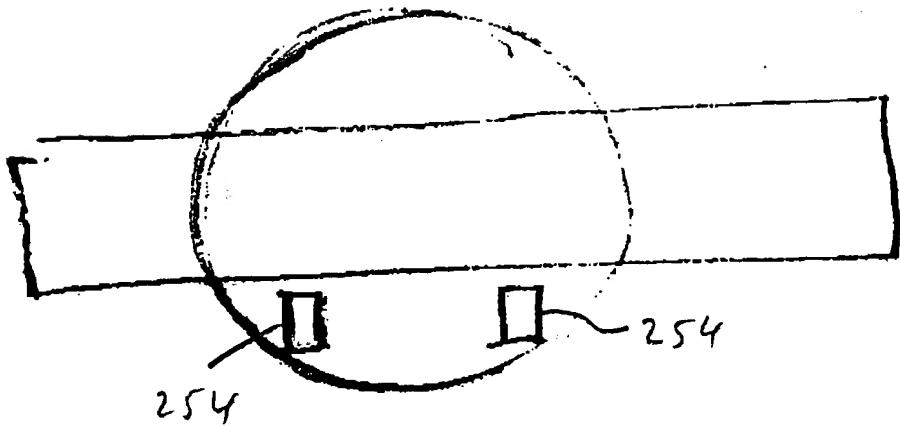


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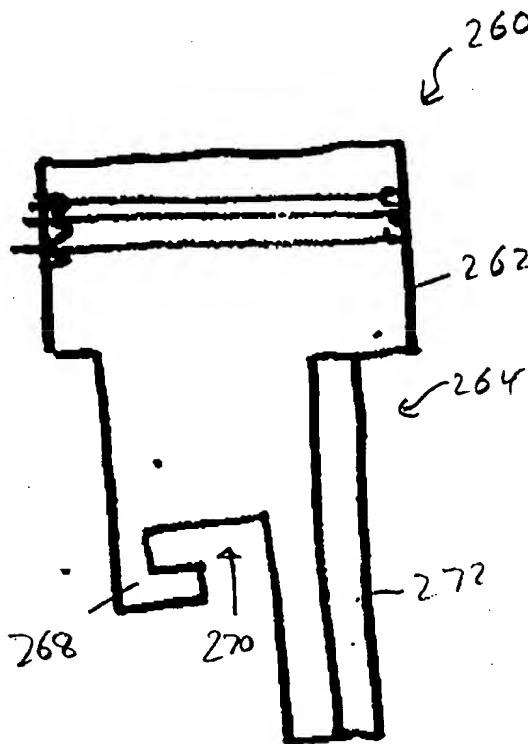


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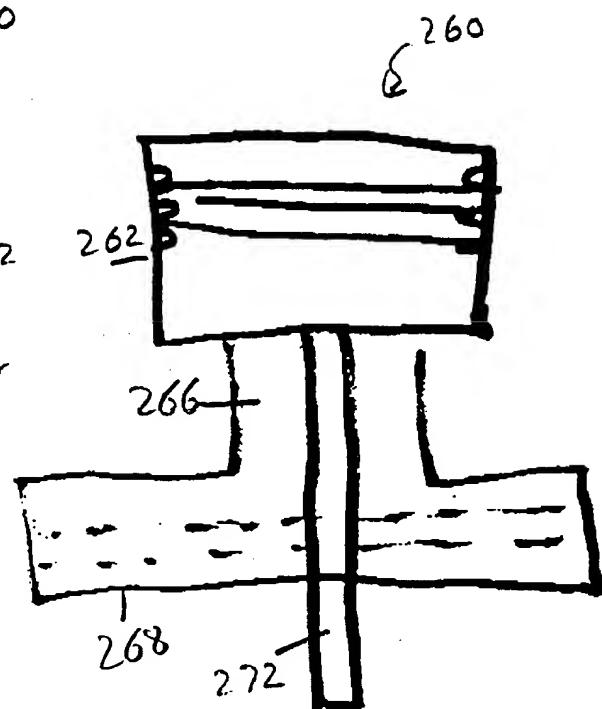


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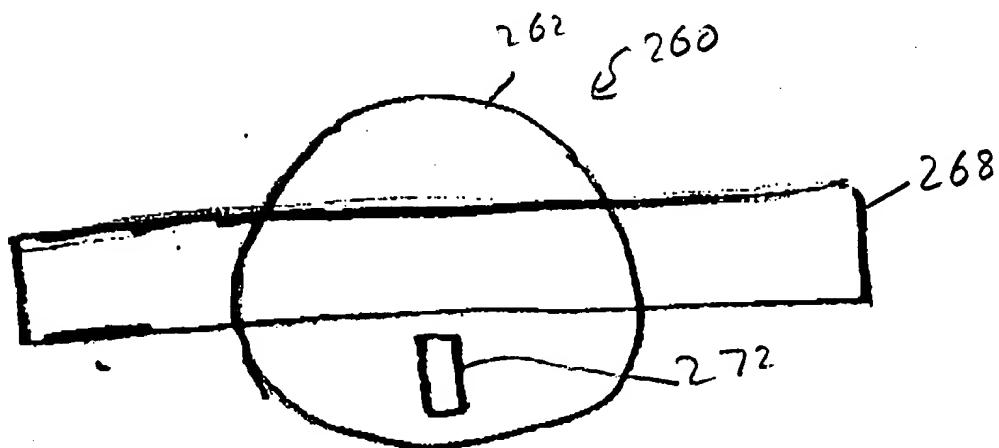


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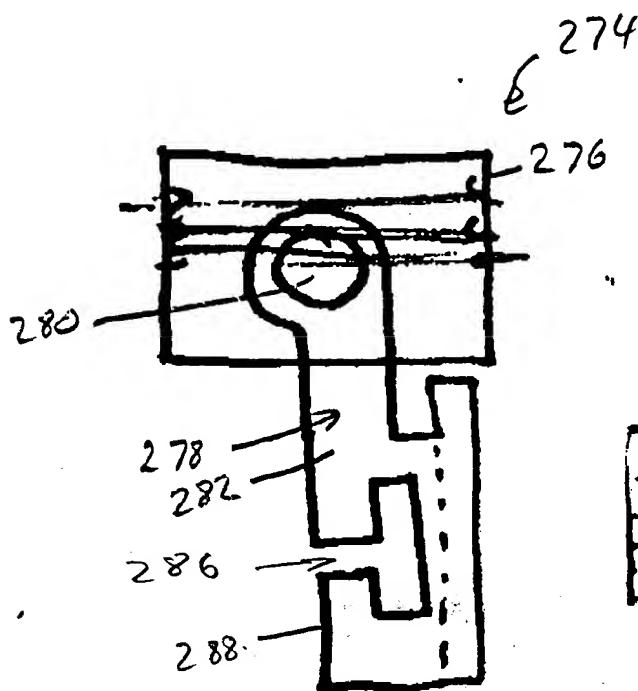


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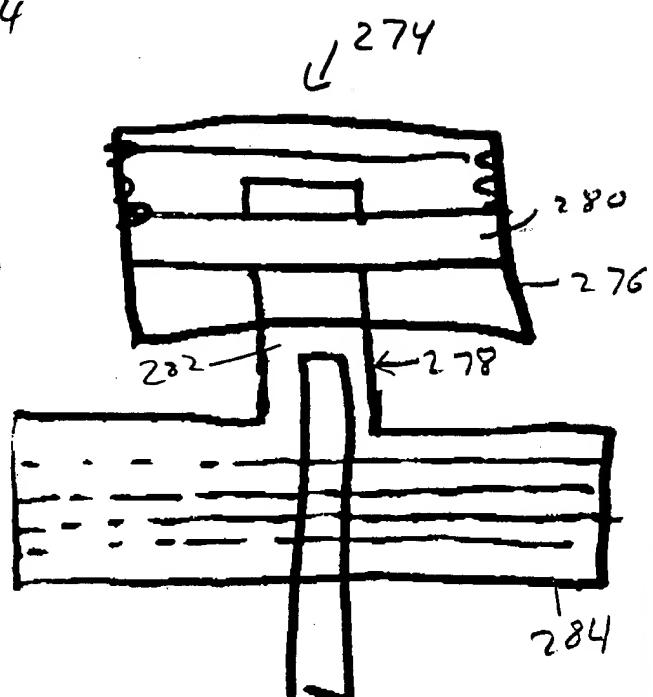


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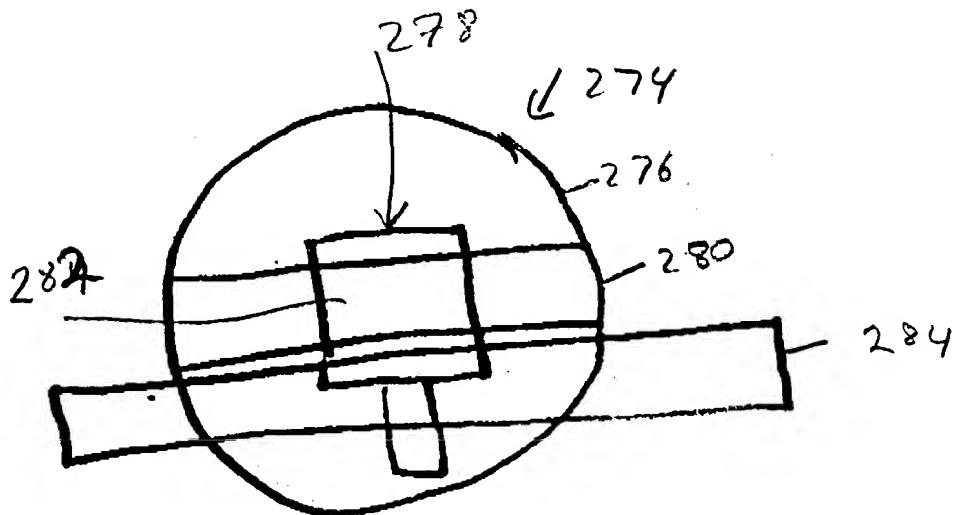


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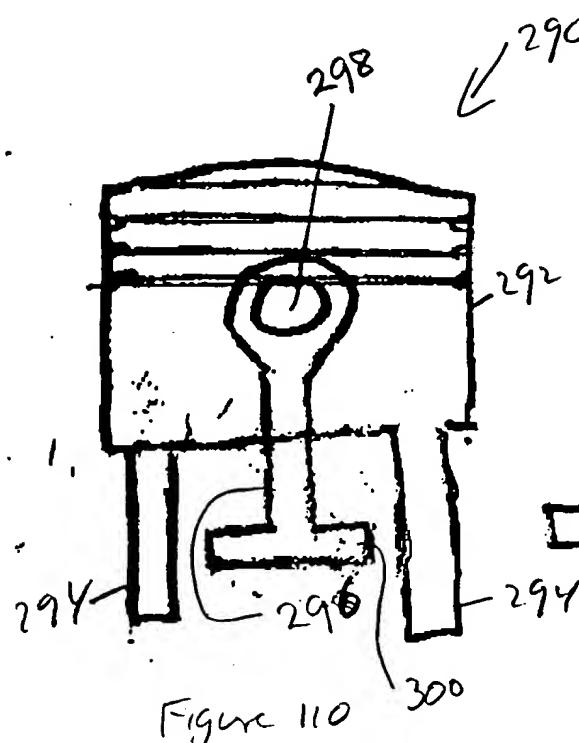


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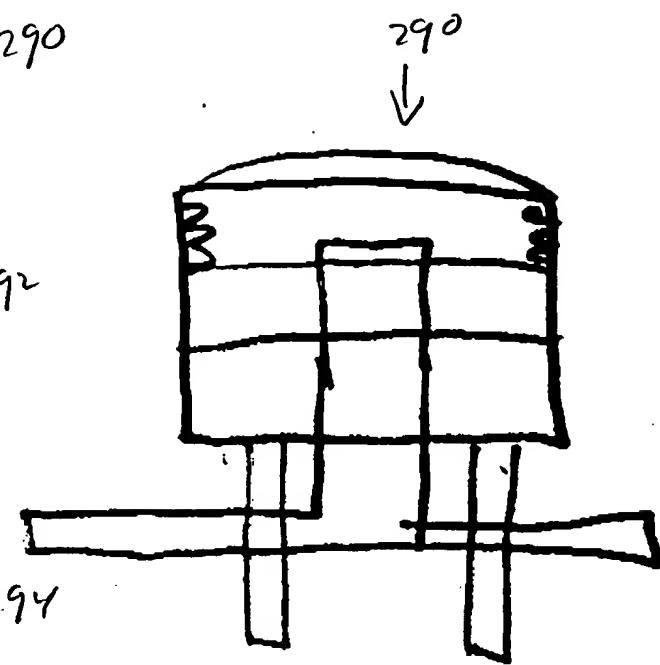


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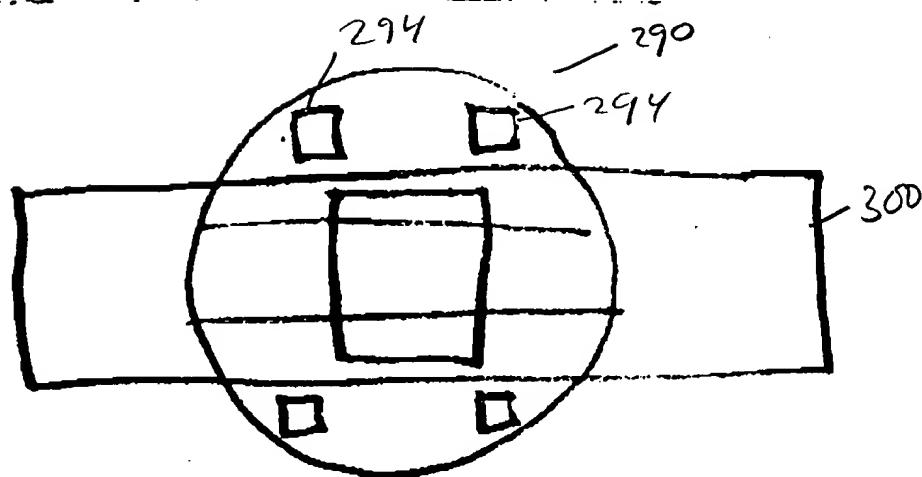


Figure 112

